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# Journal of Contemporary Research in Education



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# Journal of Contemporary Research In Education

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# Journal of Contemporary Research In Education

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# Journal of Contemporary Research In Education

VOLUME 3 | NUMBER 3 | APR. 2015

---

## TABLE OF CONTENTS

### Guest Column

*Research in Higher Education: The Neverending Story*

Alice M. Clark

75

---

### Feature Articles

*Teachers' needs and preparation to use technology in the U.S. and Japan K-12: Learning from teachers*

Svjetlana Curcic

Makito Yurita

Kathryn Young

Lori Wolff

Zora Ziazi

Elena Garcia Ansani

79

---

*Contingent Rewards in the Elementary Classroom: The Teacher's Perspective*

Steven J. Bourgeois

94

---

*Uniform Policies, School Violence, and School Outcomes: From Principal's Perspective*

Seunghye Han

109

---

*Educating Engineers*

A. Louise Perkins

122

---

-----  
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# **G u e s t C o l u m n**

*“Wisdom begins in wonder.” – Socrates*

Anyone who conducts research will attest to the fact that every answer revealed generates at least one more question. While this endless game of “whack-a-mole” might frustrate most people, I believe it is this pursuit of never-ending questions that most motivates academic scholars.

Why? Research, scholarship, creativity, and innovation are fueled by curiosity and the drive to improve the human condition. Whether it’s understanding the origins of the universe, the mechanistic workings of a subcellular organelle, the causes of human conflict through the course of history, or the most effective pedagogical techniques to inspire learning, research questions are pursued in generally the same way: ask the question, determine the answer(s), use the answers, discover new questions, and repeat. It’s a cycle powered by creativity, resourcefulness, collaboration, observation, and perseverance. We, the scholars of academia, are a key component of this successful cycle, but like any other cycle, we depend on many other factors to succeed.

The professoriate has a unique role and responsibility to pursue questions and problems that may broadly benefit society. This stands in contrast to research in business, government agencies, or the nonprofit sector, where research must specifically benefit a particular mission or purpose, and therefore, may be directed more by institutional interests than by individual creativity and curiosity. Academic scholars pursue knowledge without regard to immediate utility, bottom line, or accepted norms. In fact, I would argue that conducting research and scholarship that challenges existing paradigms is a role uniquely conferred to academic scholars. The challenge is that there are limited resources

available to conduct such research and scholarship. That's why it's essential that our society must continue to take every opportunity to champion investment in higher education research and scholarship – and see this as an investment in the betterment of society, whether realized immediately or, more likely, in the distant future.

*"The greatest obstacle to discovery is not ignorance - it is the illusion of knowledge."* - Daniel J. Boorstin

All research begins with a question to be answered, a problem to be solved. It is vital to see the origination of questions and the identification of problems as a collective task, not an individual endeavor. When we, as academic scholars, see our students, our graduates, our colleagues, and our practitioners as partners in the quest for new information, we will not be bound by the illusion of knowledge.

I recall a situation many years ago when I was teaching a class of undergraduate pharmacy students. I was asked a question by a talented and inquisitive undergraduate student (Melissa Flagg, now Ph.D., Deputy Assistant Secretary of Defense, Research and Engineering, U.S. Department of Defense). I did not know the answer to the question, and I had learned by then to simply admit it when that was the case. Melissa apologized for asking, and I explained that, contrary to being unhappy about her question, I was very pleased, as it allowed me to explain why I encourage all students to ask difficult, thought-provoking questions. If I did not know the answer, there were only two possible explanations: (a) the answer is known, and I just don't know it, or (b) the information is not known — nobody knows it. If the answer is known, then I (and my students) should look up the answer and learn something. If the answer is unknown, is it something that should be known? If so, it is a potential research question.

Assuming we could develop a testable hypothesis to answer the question, we could then devise a research plan, which, when executed, would provide new information and insights for the field, and eventually become part of what we teach our students and what our graduates use in their work.

While it is a cycle that takes some time to complete, it is the asking of the question that initiates the process. If you know the answer (or think you do), or if you have the solution (or think you do), there is no motivation to seek new information or to develop new solutions. Yet not many questions or problems have been optimally answered or solved; this is the need that motivates research and the never-ending story of academic scholarship.

The "illusion of knowledge" is the main reason I always encourage students to *question everything*. In my experience, some of the most thought-provoking questions are asked by those who are not so expert in a particular subject that they are constrained by the "illusion of knowledge." It is also this very sort of experience that makes an education at a research university distinctive and valuable. With scholars in the classroom, students are learning from those who shape the field, are encouraged to think more deeply about what they're learning and how to use it, and ask probing questions that challenge the existing body of knowledge and stimulate new thinking. Such experiences benefit both the students and the faculty.

Since most students will not pursue graduate education or become researchers themselves, their connection to faculty scholars is vital for identifying and communicating the challenges and problems they will face as professionals. After all, it is the educator who sees the shortcomings of existing pedagogies, the physician who is most aware of unmet therapeutic needs, the engineer who can see



where new technologies are most needed. Like the student who asks a question that currently has no answer, the practitioner observes problems that need solutions — both should inform new research areas. And faculty benefit from having their views and ideas challenged, which should lead to better research and scholarship.

Good research — or more accurately the results of good research — should drive sound public policy, professional practices, consumer behavior, and major technological advances in the fields of education, healthcare, engineering, technology and the environment. Good research requires critical thinking, which makes for much better problem solving and ethics because it removes bias and ensures openness to other interpretations of data. This is true whether the research is primary or secondary — the value of the research is only as good as the experimental design and objective interpretation of the data.

For example, in primary research, where new data is acquired firsthand through experiments, it is vitally important to recognize the constraints of the data acquired and resist the temptation to disregard data that does not seem to ‘fit.’ Most primary research begins with a hypothesis, comparing a null hypothesis (there is no effect of  $x$  on  $y$ ) to an alternate hypothesis ( $x$  affects  $y$ ) (Siegfried, 2010). What would happen, for example, if a researcher did not have a hypothesis to test? He or she might observe interesting patterns that may correlate, but that are not linked in a meaningful way. For example, you may find it alarming that the number of murders by steam, hot vapors and hot objects annually has an 87% correlation with age of Miss America (Fletcher, 2014). Does this mean the Miss America pageant must strive to select ever-younger winners as a public health safety measure? Of course not. This is an extreme example designed to illustrate the distinction between causality and correlation

and, more importantly, to underscore the importance of knowing the constraints related to data interpretation, especially when such interpretations may become the basis for public policy, professional practices, or curriculum content.

Similarly, when primary research suffers from inadequate experimental design, the result is multiple conflicting studies that lack statistical and predictive power. Since secondary research is collation and summation of previously published primary research data, it necessarily relies on the ability to determine if the previous work was sufficiently rigorous to be included in analysis. Making sense of multiple primary research studies is a science into itself. How do we evaluate various sources and types of information to draw sound conclusions and make informed decisions? Is it enough to have a leader in the field summarize the results in a narrative review? While a summary may be helpful to clarify concepts and provide a historical perspective, narrative review may be subjective and may not have concrete criteria for including or excluding particular studies. Consequently, two experts could review the same subject and report different conclusions (Koricheva and Gurevitch, 2013). Without a critical mass of quality primary research, secondary research cannot lead to sound conclusions.

Both primary and secondary research provide excellent training in critical thinking. Understanding how to conduct primary research — from developing sound hypotheses to proper experimental design and data interpretation — and having the tools to evaluate the existing body of information through secondary research should be part of our undergraduate and graduate-level educational literacy. After all, these undergraduates and graduate students make up our future, and sound policy decisions rest on the ability of policy makers, legislators,

journalists and the general public to understand societally-relevant academic research (Gormley, 2011), whether primary or secondary.

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### **Abstract**

A body of literature on the changing nature of knowledge acquisition, teaching, and learning with technology, has been rapidly growing within the last decade. In examining how teachers learn to use technology in the U. S. and Japan, it seems that those processes follow a similar pattern: to some extent, teacher preparation programs prepare future teachers in technology use. Frequently, however, many students learn how to use technology (e.g., various computing devices and software) on their own. Because technology is constantly evolving, it seems that those responsible for regular professional development, such as school districts (U.S.) and the Board for Education (Japan), should be much more engaged in providing up-to-date training in how to use technology, and more importantly, in – how to integrate technology into instruction across curriculum.

The U. S. National Educational Technological Plan 2010 calls for revising standards and learning objectives through incorporating technology across all content areas to improve learning (U. S. Department of Education, 2010). With more than 40 U.S. states implementing the Common Core State Standards (CCSS) in the 2014-2015 academic year, integrating technology is not a matter of choice, but part of a curriculum that starts in elementary school (National Governors Association & Council of Chief State School Officers, 2010). Students are expected to gather, assess, and apply information from both print and digital sources in conducting research, and combine information gathered from multiple sources, including videos, into their own texts or presentations (Graham, MacArthur, & Fitzgerald, 2013).

Integrating technology into K-12 schooling is not a novelty. Many teachers across the U.S. and Japan have been teaching their students with technology and how to use technology, including software, for a number of years. In the U.S. K-12 schools, there is an increased focus on providing access to the general education curriculum for all students, including special education students and English language learners, and designing instruction based on the principles of the Universal Design for Learning (UDL). Edyburn (2010) proposes that technology is essential for implementing UDL principles in instruction. Instruction based on the UDL principles implies technology considerations with adequately prepared teachers. As technology keeps advancing, the concept of “adequately prepared” teachers is hard to define. Studies reveal that teachers need to assume a dual role when it comes to

integrating technology into their classrooms: the role of a learner and that of an “instructional designer” (cf. Koehler & Mishra, 2008; Ronnkvist, Dexter, & Anderson, 2000, p. 26).

Since Cuban (2001) observed that a small number of teachers were serious computer users, less than 10% in his view at the time of his writing, a number of studies examined the use of technology in classrooms (e.g., Gray, Thomas, & Lewis, 2010; Hutchison, & Reinking, 2011). For example, based on the U.S. national survey, Gray, Thomas, and Lewis (2010) report that teachers or their students used computers in the classroom often (40 %) or sometimes (29 %). The teachers reported that K-12 students were involved in writing, creating or using graphic or visual displays, practicing basic skills, conducting research, corresponding with others, contributing to blogs or wikis, using social networking websites, solving problems, analyzing data, conducting experiments, developing multimedia presentations, creating art, music, movies, or webcasts, developing or running demonstrations, models or simulations, designing and producing a product. However, Gray et al. (2010) also noted that the coefficient variation was greater than 50% and, therefore, advised interpreting data with caution. Nonetheless, the spectrum of instructional activities with technology reported by Gray et al. (2010) is certainly much wider in scope than activities reported by Cuban (2001).

Cuban (2001) remained skeptical about the value of technology in the classroom because he observed that some teachers adopt new technologies, but sustain old practices in their teaching. Our own observations in the K-12 classrooms over the past decade across six U.S. states (California, Colorado, Illinois, Michigan, Mississippi, Texas) have not completely refuted Cuban’s claims. A number of schools have computers, connection to the Internet, LCD projectors, and, increasingly, iPads or other tablets. There are many forms of electronic books available that could make reading experiences interactive, engaging, and more individualized (Hutchison, Beschoner, & Schmidt-Crawford, 2012). There also are numerous websites and electronic texts that

bring history to life, or sites on which students can virtually dissect frogs (Okolo, 2005). However, we also have observed elementary classrooms in which each student is provided with a tablet and the teacher reading aloud a digital book presented in black letters on a white digital screen, the same way as the text would appear in a printed book.

Based on our observations across six U.S. states and teacher preparation programs in large metropolitan areas in the U.S. and in Japan, we observed and, also, learned from teachers and teacher candidates that: 1) not all classrooms are equipped with technology (beyond, e.g., one computer); or (2) technology is in place, but the teachers do not use it, or, (3) do not use it adequately for various reasons. This discrepancy between various reports and observations from the field prompted us to further investigate teachers’ preparation in technology use. The literature review by Hew and Brush (2006) is closer to our observations because they identify direct and indirect barriers to technology integration in K-12 instruction. The authors note that the direct barriers include: (a) teacher’s attitudes and beliefs related to technology use; (b) the teacher’s perceived knowledge and skills; (c) the influence of institution (e.g., internal policies to use technology within certain subject areas introduced top-down), and, (d) resources. The authors also suggest that there are indirect barriers such as departmental cultures and assessment (e.g., “the use of graphing calculators might be encouraged or not because they are prohibited in high-stakes testing”) (Hew & Brush, 2006, p. 232).

In considering what knowledge teachers bring to the K-12 classrooms in terms of technology and their preparedness to use it, a question worth pursuing is: How do teachers learn about technology to be used in K-12? We consider an answer to this question a missing “variable” in the model presented by Hew and Brush (2006) and aim to provide a more nuanced understanding about teachers’ preparation to use technology. To broaden our perspectives on teacher preparation, we collaborated with colleagues from Japan. Some

schools have been inspired by the lessons learned from Japan since the late 1990s. (e.g., Yoshida, 2001). To learn more about teacher preparation to integrate technology into instruction, we surveyed teachers in the U.S. and Japan.

### **Theoretical framework**

A number of authors note that the epistemology of knowing in a digital age should be reconsidered in view of information-communication technology (ICT) in general, and the Internet, in particular (e.g., Coiro, Knobel, Lankshear, & Leu, 2008a). For example, Lankshear, Peters, and Knobel (2000) suggest that learning from an ICT perspective is not only about content mastery, but also about mastering and possessing skills necessary to perform certain activities; for example, how to create hyperlinks or make use of the links on the Web; how to use, learn, or program computer languages; or, how to select, evaluate, or use information sources. Lankshear et al. (2000) propose “performative epistemology” (after Wittgenstein) referring to understanding and knowing as “making, doing, and acting” (p. 21). Lemke (1998) suggests that information technologies make possible “new paradigms for education and learning” and allow a shift toward “interactive learning” (p. 287). Within the paradigm of interactive learning, a teacher’s task becomes helping children “learn how to learn” new technologies of literacy (Leu, 2002, p. 313). Spiro and Jehng (1990) use a metaphor of crisscrossing conceptual landscapes (also after Wittgenstein’s *Philosophical Investigations*) suggesting that knowledge that will be “used in many ways is taught in many ways” (p.171).

A common thread across the above accounts is the assumption that isolated pieces of information do not lead to the acquisition of knowledge and understanding. Within electronic environments, educational tasks assume new complexities. Some authors draw attention to instruction, especially literacy instruction broadly conceived - as inadequate (Leu, Kinzer, Coiro, & Cammack, 2004; Leu, Forzani, Rhoads, Maykel, Kennedy, & Timbrell, 2014). Leu and colleagues view ICT technologies,

particularly the Internet, as essential in preparing students for new literacies because new technologies are seen as central to the acquisition of knowledge. Some tasks, such as inquires on the Web, demand that students coordinate a number of activities that are more open in nature than reading informational text in a textbook followed by a specific set of questions. A Web-related task may start with an information search within hypertext, which is essentially an open-ended text structure with no particular middle or end point. Students are expected to design their own paths in constructing meaning. Therefore, reading in different media may involve different processes (e.g., Leu et al., 2014; Wyatt-Smith & Elkins, 2008).

The multimodal nature of online texts (e.g., texts with embedded hyperlinks, icons, buttons, text-to-speech function, etc.), along with a shift toward online assessment in the CCSS, necessitates teachers’ understanding of online skills. Yet, while teachers are able to refer to the curriculum standards, there is no instruction how to teach the standards (Calfee & Miller, 2013), including those related to online skills (online reading, comprehension, research, etc.). In considering the role of the teachers in the context of the Internet and other ICT technologies in the classroom, Leu et al. (2004) argue that the role of the teacher will increase, rather than decrease, in view of their central role in creating learning experiences for their students. Therefore, teachers’ preparation to use technology remains an important topic.

The focus on teachers’ processes of learning and knowing is also important in the climate of ever-increasing discussions on how to best prepare our future teachers (Darling-Hammond & Bransford, 2005; National Research Council, 2010; Wilson, 2009). While the current discussions center on the role of teacher education programs as opposed to apprenticeship models where teachers learn as they teach (after a brief period of training), it seems important to understand teachers’ perspectives on their preparedness to integrate technology into their instruction, regardless of the way they came to join the profession. We,

therefore, set out to learn the ways in which: (1) teachers learned to use technology; (2) their perceptions about preparedness to use technology, and (3) their actual use of technology in the U.S. and Japanese K-12 classrooms.

## Method

We examined teachers' perceptions of their preparedness to use technology, the actual use of technology in their classrooms, and the ways they learned about those technologies, through a semi-structured questionnaire.

*Participants.* Our participants were teachers in three metropolitan areas in Midwestern and Mountain states in the U.S. and in Japan. We purposefully selected schools situated in different neighborhoods of several large cities. We asked administrators (e.g., assistant superintendent, assistant principal, special education coordinator) to share the questionnaire with their teachers. The teachers were asked to anonymously complete the questionnaire and place it in a specified box at school. We concluded collecting the questionnaires once we reached the total of 117 responses of the U.S. sample ( $n=100$  of experienced teachers), with a small number of preservice teachers ( $n=17$ ) and 117 of the Japanese sample ( $n=71$  of experienced teachers and  $n=46$  preservice teachers).

The U.S. sample comprises 91% Caucasian teachers, 3% African American teachers, 5% Hispanic teachers, and 1% "Other" teachers, in terms of ethnicity; ( $N=117$ , age  $M=35$ ,  $SD=10.41$ ), and gender: female = 82%, male = 18%. (Comparable to a national sample: females: 84%, males = 16%, with a slightly higher Caucasian percentage than nationally (Feistritzer, 2011). Due to "lost in translation" factors we do not have the same breakdown for the Japanese sample.

*Instrument.* A semi-structured questionnaire contained a set of closed questions and a set of open-ended questions. As Hew and Brush (2007) note, there is a lack of clear definition of technology integration, but there

are elements across a number of studies that together denote technology integration as various uses of computing devices in instruction and we framed the questions to reflect those uses.

The closed questions pertained to teacher demographic information and questions related to the sense of preparedness to use computer technology in the classroom (e.g., incorporate Internet resources, desktop applications such as PowerPoint, Excel, etc., and interactive boards – for example, Whiteboard/Smartboard, etc.), frequency of technology use in the classroom, and teachers' K-12 experiences with technology during their own K-12 schooling. Open-ended questions asked teachers to relate: (1) What technology (including software and Internet resources) they learned about in their teacher education programs?; (2) What technology they learned about outside teacher education programs?; (3) To share other experiences and thoughts related to computer technology, and, (4) Those who had experience with technology during their own K-12 schooling were asked to describe those experiences.

Two of the authors conducted qualitative analysis of the open-ended part of the questionnaire and coded the emerging themes. The interrater reliability conducted for 25% of the sample was high (98%), and the rest was resolved through discussion.

## Results

We first report our findings based on the quantitative data analysis based on the closed-ended part of the questionnaire and then the qualitative data analysis based on the open-ended part of the questionnaire. Teachers' perceptions about preparedness to use technology and the actual use of technology in the U.S. and Japanese K-12 classrooms is discussed next. How, and what specific technologies teachers learned to use, we present in the section on Qualitative results.

*Quantitative findings.* There is a significant, small to medium association,

between the sense of preparedness to use technology and the frequency of using technology ( $r = .30, p = .01$ ) for the U.S. sample. The Pearson correlation is stronger for those over 40 years of age ( $r = .44, p = .035$ ). Similarly to the U.S., there is a significant association between the sense of being prepared to use of technology and the actual use of technology in the classroom ( $r = .349, p = .003$ ) among the experienced teachers in Japan.

We differentiated some of the analyses based on whether the teachers were special education teachers versus general education teachers in the U.S. Our assumption was that the special education teachers might integrate technology into their teaching more often because of the nature of their teaching that is geared toward the special education population of students (e.g., some special education students require the use of assistive technology). Surprisingly, a larger percentage – 53% of general education teachers ( $n=57$ ), had a higher sense of being prepared to use technology in the classroom as opposed to 28% of the special education teachers ( $n=43$ ). Thirty-nine percent of the general education teachers reported that they actually used technology daily in the classrooms, while only 29% of the special education teachers reported that they used technology daily. Also, contrary to our expectations, 17% of the special education teachers reported that they hardly ever or never used technology in the classroom, while 11% of the general education teachers reported they hardly ever or never used technology in their classrooms.

Overall, the U.S. experienced teachers reported feeling more prepared than Japanese teachers to use technology ( $\chi^2 = 64.987, p = .001$ ). The U.S. teachers also reported using technology more frequently in the classrooms ( $\chi^2 = 69.012, p = .001$ ). Seventy-three percent of the U.S. teachers reported using technology daily or two-three times per week, while only 13% of experienced teachers in Japan reported using technology on a daily or weekly basis.

We also were interested whether there would be any difference in the feeling of

preparedness to use technology if teachers experienced the use of technology during their own K-12 schooling or not. There was no significant difference in the sense of preparedness between those who experienced technology in K-12 classrooms during their own schooling and those who did not ( $t = 1.658, p = .101$ ) for the U.S. sample. Also, there was no significant differences between the actual use of technology in instruction and those who experienced during their own K-12 instruction with technology or not ( $t = .873, p = .385$ ). Because of the limited number of the U. S. preservice teachers, we did not include the analysis for that group.

Among Japanese experienced teachers, there was a significant difference in the sense of preparedness to use technology between those who experienced technology in K-12 classrooms during their own schooling and those who did not ( $t = 2.303, p = .024$ ). Those who experienced technology integration within their own K-12 schooling had a higher sense of preparedness, although a limited number of Japanese teachers reported that they experienced instruction with technology during their own schooling (22%). The analysis for the Japanese experienced teachers related to their actual use of technology and the independent variable related to whether they experienced instruction with technology during their own schooling or not, revealed no significant relationship ( $t = .649, p = .519$ ) as was the case with the U.S. experienced teachers. For the preservice Japanese teachers, there was no significant difference in their plans to use technology in K-12 and their own experience during their K-12 schooling in terms of whether they had some experience in K-12 schooling with technology or not ( $t = .289, p = .776$ ).

*Qualitative findings.* We report here the training in technology based on the analysis of where the teachers reported to have developed the knowledge across hardware/software. We coded the categories that emerged based on our analysis (as reported by the teachers) under: desktop applications (Table 1), Web Applications, Digital Photo and Manipulation Software (Table 2), Learning Technology and Software (including mobile) (Table 3), Social

Media/Media Aggregator (Table 4), Web design software (Table 5), Internet sites/portals/data bases (Table 6), and Special education (Table 7) for the U.S. sample. The tables also present the findings related to how teachers learned about certain technology or applications under: Teacher education programs, District training, and Self-instruction. Table 8 summarizes specific technology that Japanese teachers learned through their Teacher education programs, seminars offered by the Board of Education, and Self-instruction.

Table 1  
*Desktop applications*

|                  | Teacher education | District training | Self-taught |
|------------------|-------------------|-------------------|-------------|
| Microsoft Office | X                 |                   | X           |
| Word             | X                 |                   | X           |
| PowerPoint       | X                 | X                 | X           |
| Publisher        |                   |                   | X           |
| Print Shop       |                   |                   | X           |
| Excel            | X                 | X                 | X           |

Table 2  
*Web Applications, Digital Photo and Manipulation Software*

|                  |            | Teacher education | District training | Self-taught |
|------------------|------------|-------------------|-------------------|-------------|
| Web Applications | Animoto    |                   |                   | X           |
|                  | Comic life |                   | X                 |             |
|                  | iPhoto     |                   |                   | X           |

|                                      |                                |   |   |   |
|--------------------------------------|--------------------------------|---|---|---|
|                                      | Photo Story                    |   | X |   |
|                                      | Photo bucket (Big Bang Photos) |   |   | X |
|                                      | Picture It                     |   | X | X |
| Interactive electronic boards/camera | Smart Board                    | X | X | X |
|                                      | White board                    | X | X | X |
|                                      | ELMO                           | X | X | X |
| Electronic texts                     | Audio/Video books              |   |   | X |
| Graphic design software              | Adobe illustrator              |   |   | X |

Table 3  
*Learning Technology and Software (including mobile)*

|   |   | Teacher education | District training | Self-taught |
|---|---|-------------------|-------------------|-------------|
| Mobile Device                                   | Electronic Braille Note Taker               | X                 | X                 |             |
|   | iPad  |                   |                   | X           |
|   | iPod  |                   |                   | X           |
|   | Smart Phone                                 |                   |                   | X           |
| Pod casting, audio capture and editing software | Podcasts<br>Audio interviews<br>Garage Band | X<br>X            |                   | X<br><br>X  |
| Flip camera                                     |   |                   | X                 | X           |
| Clickers  |   |                   | X                 |             |

Table 4



*Social Media/Media Aggregator*

| Social media/media aggregator | Teacher education | District training | Self-taught |
|-------------------------------|-------------------|-------------------|-------------|
| Blogs                         | X                 | X                 | X           |
| Facebook                      |                   |                   | X           |
| Skype                         |                   |                   | X           |
| VoiceThread                   |                   | X                 |             |
| YouTube                       | X                 |                   |             |

Table 5  
*Web Design Software*

| Web Design      | Teacher Education | District Training | Self-taught |
|-----------------|-------------------|-------------------|-------------|
| Build a Webpage | X                 |                   | X           |
| Dreamweaver     |                   |                   | X           |
| Frontpage       |                   |                   | X           |
| HTML            |                   |                   | X           |

Table 6  
*Internet sites/portals/data bases*

| Internet               | Teacher Education | District Training | Self-taught |
|------------------------|-------------------|-------------------|-------------|
| ERIC database          | X                 |                   |             |
| Wikis                  | X                 | X                 |             |
| Web pages (in general) | X                 |                   | X           |

|                                     |   |   |                     |
|-------------------------------------|---|---|---------------------|
| (Web sites - specific):             |   |   |                     |
| Brain pop                           | X |   | X                   |
| CEC                                 | X |   | X (also NCTM, NSTA) |
| Aleks.com                           |   | X |                     |
| Rio Curriculum                      | X |   |                     |
| enVisionMath                        | X |   |                     |
| wrightslaw                          | X |   |                     |
| flocabulary                         | X |   |                     |
| starfall.com                        | X | X | X                   |
| trackstar4teachers.com              | X |   |                     |
| Web quests                          | X | X | X                   |
| read.write.think                    | X |   |                     |
| thinkfinity                         |   |   | X                   |
| Graphing globes                     |   |   | X                   |
| Resources for Planning              | X |   | X                   |
| Games for students                  | X |   |                     |
| Moodle                              | X | X |                     |
| Google docs, sites, wikis, calendar | X | X | X (also, gmail)     |
| Google Earth                        | X | X |                     |
| WisWeb (Java applets for math)      | X | X |                     |
| Geometers Sketchpad                 | X | X | X                   |
| Online math manipulatives           | X |   |                     |
| Survey monkey                       | X |   |                     |
| Geogebra                            | X |   |                     |

|   |  |   |  |
|---|--|---|--|
| Infinite campus (grades), teacher portal for data, School Center, Reading 180 |  | X | X (Infinite campus, teacher portal for data) |
|---|--|---|--|

Table 7  
*Special Education technology/software*

| Special education            |  | Teacher education programs | District training | Self-taught including friends /colleagues |
|------------------------------|--|----------------------------|-------------------|---|
| Special Education software   | Easy IEP                                 |                            | X                 |   |
|                              | Special Educ. Automation software (SEAS) |                            |                   | X   |
| Speech recognition           | Text-to-Speech                           | X                          |                   | X   |
|                              | Screen Reader                            | X                          |                   |   |
|                              | Dragon Speak Natural                     | X                          |                   |   |
| Eye tracking technology      | Eyegaze Edge                             | X                          |                   |   |
| Picture Communicate Software | Board maker                              | X                          | X                 | X   |

Various issues were identified as important in integrating technology into instruction. The most frequent responses related to: (1) training; (2) access (to hardware in schools); (3) positive responses related to technology; but also, (4) responses that could be qualified as negative or skeptical; followed by (5) technology referred by some teachers in the future tense; and, (6) some special education teachers mentioned that they used computers predominantly to develop Individualized Education Programs (IEPs, which we presented

under a specific use of technology. We further elaborate on these points:

*1. Training.* The following response best exemplifies a dozen of the responses that focused on training that is viewed as important and that also should be ongoing: “Tech training should be an on-going thing since there are always new programs and/or programs to manage daily responsibilities as well as learning how to incorporate it into lessons for students.”

Some teachers advocated for technology training to be offered every year by the district: “The teachers should be paid to take these training classes if they’re required to use it in their classes. Technology classes should be offered every year by the district.” Or, “Teachers should be taught how to incorporate computers into their classrooms - could be just professional development.” Some teachers simply wished for “more training” or for “teacher ed programs to do a better job”.

*2. Access.* The following response illustrates some of the frustration related to access to technology: “Would like to see access to technology grow – at times limited access in schools can make technology difficult to use”. Also, there is a sense of frustration with “laptops that do not stay charged”, “urban schools that don’t have access to technology”, minimal access to Smartboards, document cameras, computers (e.g., “It can be very hard to schedule computer lab in a school with 480 students - elementary”; “I have only one computer in my classroom”), and finally: “I think that computer technology is a very needed skill that today’s student needs to engage in. However, I worked at a school that had an ‘unsatisfactory’ rating from the state. Therefore, all of our attention was constantly focused on teaching as much material as needed before the test, and computer training and exploration was never anything we could really indulge in with our students. When we could access computers, many were old and broken, and though our principal made a great effort to replace them last year, there were usually only enough for one class at a time to be in our computer lab.”

### *3. Positive views related to technology.*

Some of the most positive views on integrating technology into classrooms were related to the engagement of the students and the possibility to enhance their learning. For example: “Using technology engages and enhances the learning of our students, and as educators – isn’t that our goal?; “... a great way to engage kids, especially those who are harder to engage”; “There are WONDERFUL resources available on the Internet, both free and by subscription. Simulations can provide visuals for students that are not available otherwise”.

In addition, some teachers noted that technology is a way to prepare students for the “real world”. For example: “The more we can incorporate computer technology into the classroom – the more our students will be prepared for the ‘real world’ (e.g., completing online applications, paying bills online, etc.).

Some teachers sounded truly enthusiastic, for example: “I love technology. I think possibilities are endless and progress is amazing. I like Smart Boards, etc. CIT can give voice to those who can’t speak, read out loud to those who can’t read, provide individual assessment, etc.” Specifically, from a perspective of a special education teacher: “Technology for my special needs students has been a huge help – is allowing them to successfully assist their learning, such as writing programs and reading programs.” And, from a general education teacher: “...the Smartboard and having kids draw on it in order to assess student learning has been a revolutionary tool in my U.S. history class”.

*4. Negative/skeptical views.* The first response reflects several teachers’ responses that did not seem to value the use of technology because in their views the use of technology does not necessarily translate into either learning or engagement of the students. For example, “I do not want to use technology just for the sake of using it. If it does not translate into student learning or increased engagement (which always leads to increased learning) I shouldn’t do it.” Or: “I think our students process information faster, but they do not retain it”.

Several teachers noted that teaching and learning content is more important than integrating technology into instruction, especially because according to some of those teachers, students learn about technology outside their classrooms. For example: “Computer technology is great, but should not overtake everything schools are doing. The kids learn a lot of those skills on their own outside of school.” Or: “I don’t use a lot of computer-related activities with 3, 4, and 5-year olds. There are other content areas that are more important to me to teach. I know kids are spending lots of time at home in front of a computer. I believe that all kids, but especially my students, need to learn how to play w/each other, not a machine!”

There are some concerns that technology companies are driving our “consumer/innovation happy classrooms”, that computers “do have a lot of pros, but they are also taking away from our ability to relate to each other on a human level”, and finally, unlike those teachers who complain about the lack of access to technology, some reported that technology is to a certain extent effective, but as it “becomes overwhelmingly redundant in our classrooms, the kids become as numb to the ‘top-rate’ technology as they would be using a chalkboard”.

Several responses specifically addressed time as an issue. For example, “Technology should not be used if it takes way too much time to prepare something that lasts a very short time (e.g., clickers)”; “Not enough time to transfer lesson to technology devices”, “Not enough time to learn about it”, etc. Finally, one previous Computer Science major expressed his frustration with low standards and dated educational technology teacher preparation courses.

### *5. Technology in the future/present.*

Although not too many teachers responded to this theme, it is interesting to observe the ambivalence in the responses as it is not clear whether some of the teachers have decided that technology is a wave of the future or the present. For example: “It is the future and the more we

learn the better...Students naturally gravitate toward computer tech, and we teachers should attempt to service this need"; "Technology – the wave of the future and the present"; "Computer technology is the most important and least utilized. It is changing our world and has already changed the brains of our students. It makes all learning more engaging and relevant. It is not in the future, it is NOW."

6. *Specific use of technology.* Some special education teachers specifically mentioned the use of technology to complete IEP documents. For example: "Use computer more for IEP than students"; "I have to do all of my paperwork for IEP meetings on the computer", "IEP document online", and had district related training in that respect.

Table 8 summarizes specific technology that Japanese teachers learned through their teacher education programs, seminars offered by the Board of Education, and self-instruction.

Table 8  
*Desktop applications, software, Internet (Japanese sample)*

|                      | Teacher education | Board of Education | Self-taught |
|----------------------|-------------------|--------------------|-------------|
| Microsoft Office     |                   | X                  | X           |
| Word                 |                   | X                  | X           |
| PowerPoint           |                   | X                  | X           |
| Excel                |                   | X                  | X           |
| Scrivener software   |                   |                    | X           |
| Photoshop            |                   |                    | X           |
| Movie/photo editing  | X                 |                    | X           |
| Smart board          |                   |                    | X           |
| Programming          | X                 |                    | X           |
| Statistical analysis | X                 |                    | X           |
| Math software        | X                 |                    |             |
| Geometry modeling    | X                 |                    |             |
| Geo- mapping         | X                 |                    | X           |
| Internet research    | X                 |                    | X           |
| Computer hardware    | X                 |                    |             |

|                |   |  |   |
|----------------|---|--|---|
| I-pod          |   |  | X |
| Web-publishing | X |  |   |
| Blind Touch    | X |  |   |
| MS Paint       | X |  |   |

The second author, our colleague from Japan, noted that what these (Japanese) students and teachers witnessed was teachers' use of computer technology for simply substituting what has long been a part of instructional technologies in the classroom. For example, many respondents noted that their teachers used computer technology in place of a projector, a photo-slide, and/or video players. PowerPoint is the most frequently mentioned software used in their classroom learning experience with computer technology, and Word processing and spreadsheet software follow on the list. A few preservice respondents mentioned that they have used MS Paint and other graphic software to draw on a computer screen in their K-12 education. Only a few preservice teachers had some experiences in learning in a classroom where teachers used computer technology to assist transmitting complex ideas, such as modeling formulas of mathematics and/or simulating experiments in physics.

Second, the qualitative analysis of the semi-structured questionnaire (Japanese sample) reveals that the Teacher education courses were not a substantial resource in preparation and use of the computer technology in K-12. Some participants have learned to use Word-processing, Excel, and presentation software in the process of completing their course requirements. Only a handful have learned Web publishing and the use of Internet as a part of their research tools. Three preservice teachers responded that they have learned computer mechanism, but the course syllabus (and an interview with one of three) revealed that they in fact studied a history of computers as a part of general education courses. The overwhelming focus on office software, however, shows that Teacher education courses generally ignore the use of computer technology as a tool for classroom instruction. Instead, Teacher education courses assume the use of computer technology in the classroom is for classroom

management and other administrative lines of work in schools—grading, composing newsletters, drafting letters, creating quizzes, and so on. Some participants responded that they have attained some computer skills at work or at volunteer sites, but those skills again were limited to classroom management and administrative side of the job.

Finally, our colleague from Japan, just as the U. S. colleagues, recommends integrating technology across university courses. In both samples, teachers seem to be learning about technology in some Teacher education courses, with many teachers simply learning a lot on their own. Based on our findings of both quantitative and qualitative data, we next discuss our findings related to teacher preparation to use technology.

## **Discussion**

A body of literature on the changing nature of knowledge acquisition, teaching and learning with technology, and the changing nature of literacy, has been rapidly growing within the last decade (Coiro, Knobel, Lankshear, & Leu, 2008b; Kuiper, Volman, & Terwel, 2005; Leu, Zawilinski, Castek, Banerjee, Housand, Liu, & O’Neil, 2007; Leu et al., 2014). Our understanding of teacher preparation as it relates to teachers’ practices in the use of technologies in their K-12 classrooms has been less progressive. Since Cuban (2001) reported that there was no clear evidence between the student achievement and use of technology, there still seems to be no overwhelming advantage reported on the use of technology and student performance (e.g., Coiro et al., 2008b). However, there is an increased recognition of the role technology plays in the acquisition of knowledge, changes taking place in workplaces, and the role technology plays and occupies in students’ lives outside the schools (e.g., Ito, Horst, Bittanti, Boyd, Herr-Stephenson, Lange, Pascoe & Robinson, 2008; Partnership for 21<sup>st</sup> Century Skills, 2006).

In examining how teachers learn to use technology in the U. S. and Japan, it seems that those processes follow a similar pattern: to some

extent, teacher preparation programs prepare future teachers in technology use. Frequently, however, many students learn how to use technology (various computing devices and software) on their own. While neither of the two findings seem particularly surprising, it is surprising that schools districts (in the U.S.) and Board of Education (in Japan), seem to offer a limited number of seminars and training sessions related to technology integration into K-12 instruction. Because technology is best mastered through hands-on experience and because technology is constantly evolving, it seems that those responsible for regular professional development should be much more engaged in providing up-to-date training.

Our qualitative data reveal that teachers would welcome more training in technology and, specifically, on the ways to integrate technology into their instruction. Some studies suggest that, indeed, well-trained teachers successfully integrate technology into their instruction (e.g., Hsu, 2010). Perhaps, a lesson to be learned from the U.S. and Japan is: Many teachers seem to be willing to learn, but we are not providing adequate education or professional development opportunities. There are exceptional teachers: for example, one experienced Japanese teacher designed software to teach mathematics and also a lesson to use that software. Although the U.S. teachers provide more and varied examples of technology use, there is no example of such an engagement that would reflect both developing a specific software and using that software within a content area (math, in this example).

We hope to have contributed to a dialogue about the need for reforming teacher education programs that would reflect the ICT performative framework across the coursework offered by universities. The question about how to prepare teachers to integrate technology into teaching and learning processes is especially important in the era of high stakes testing and the focus on online assessment. This is an urgent task in view of the fact that many teachers express concerns that the focus on testing restricts their considerations of integrating technology into their instruction in the present and other studies (e.g., Lipscomb & Dopen,

2005; McGrail, 2006). At the same time, Leu and colleagues (2014) warn that because skills related to online research and reading comprehension were not explicitly addressed within the CCSS, it is possible that the achievement gap not only in literacy, but also across various content areas, might increase rather than decrease the achievement gap among students. Their argument is based on their observation that those districts that are economically challenged are often times also lower in performing and might focus on explicit standards, interpret them in the offline context, and fail to incorporate the online skills into instruction. Consequently, Leu et al. (2014) advocate for a thoughtful integration of teaching online skills into instruction.

A very limited number of teachers in our study noted a specific content area in which they actually integrate technology into their instruction (e.g., math, history, special education). Therefore, we advocate for education and training beyond instruction in specific computing devices and software to include focus on instruction in how to integrate technology in different content areas for secondary teachers, and across the curriculum in elementary grades. While there are calls for teacher education programs to better prepare teachers in technology integration into instruction (e.g., Lipscomb & Doppen, 2005), our study indicates that perhaps even more attention to technology integration should be provided by the school districts/Board of Education and specific contexts in which teachers educate their students.

### Limitations

International comparisons have some inherent difficulties as some variables get “lost in translation” - to name only one - but pertinent to our study. As a result, we do not have the comparable information related to the demographics of our samples. In addition, due to anonymous nature of the survey, we do not have a response rate for the teachers who participated in the survey and those who did not. Inherent in a survey design is a problem associated with self-reported data that may overestimate or

underestimate teachers’ perceptions of their ability to use technology and the actual use of technology in the classrooms, although some studies show that there is a high positive correlation between teachers’ self-perceived ability to integrate technology into instruction and their frequency of technology integration (e.g., Hsu, 2010).

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*Responsive Education Solutions*

**Abstract**

With growing force, extrinsic motivators, such as stickers, certificates, gold stars, and monetary compensation, permeate the educational environment (Kohn, 1993). While innocuous on the surface, such incentive-laden practices represent a level of teacher control that has profound consequences for student motivation (Reeve, 2006). Although considerable field experiments have shown the effects of contingent rewards on subsequent intrinsic motivation for engaging in proscribed activities (Deci & Ryan, 1985), such studies do not shed light on the motivational realities of the classroom environment, complete with student discipline, standardized curricula, and accountability measures. One hundred five (105) elementary teachers of grades one to five within a single school district in the Southern United States responded to Likert-type items and open-ended questions, allowing them to articulate and justify their use of systems of rewards and sanctions in the classroom. Results indicated that the overwhelming majority of teachers (95%) had systems of rewards and consequences/sanctions, which they deemed effective and pedagogically appropriate. Teachers revealed highly developed token economies spanning both the students' behavioral and academic outcomes. While this study is descriptive and exploratory in nature, it attempts to provide context for further research in an area of pressing concern that needs to be reclaimed.

The year 2013 represented the 20<sup>th</sup> anniversary of Alfie Kohn's *Punished by Rewards* (1993), which can be viewed as a warning call concerning the unintended consequences of contingent rewards on intrinsic motivation. Kohn's plea for moderating the administration of incentives, both verbal and tangible, received a wide readership and took its place on the bookshelves of both educational researchers and practitioners. However, based upon recent educational policy and classroom practice, Kohn can be viewed as a voice crying in the wilderness. In the 20-plus years since Kohn's publication on rewards, nationally-legislated accountability measures have placed students' academic performance under the spotlight. Primarily through requirements of *No Child Left Behind* (2002), students have been subjected to an unprecedented battery of high-stakes assessments, which have transformed our definition of what it means to be well-educated (Kohn, 2004). The genius, if one can ever call it that, of *NCLB* is that it

rightfully assumed that setting accountability standards for school districts would produce a chain effect. School boards pressure district superintendents, who pressure campus principals, who pressure teachers, who pressure students. And all of it is very public, as Kohn foresaw.

With growing force, extrinsic motivators, such as stickers, certificates, gold stars, and monetary compensation, permeate the educational environment (Kohn, 1993). While innocuous on the surface, such incentive-laden practices represent a level of teacher control that has profound consequences for student learning (Burgess et al., 2004; Kohn, 1993; Popham, 2001; Reeve, 2006). Federal calls for merit pay (based in part upon value-added measurement of teacher performance through student test scores) encourage teachers to narrowly tailor their instruction toward what is tested, maximizing gains in measurable student growth, while marginalizing learning beyond the scope of the assessment.

Although external rewards and sanctions may produce short-term increases in student achievement, they also have hidden costs with respect to long-term intrinsic motivation to learn (Ryan & Weinstein, 2009). Researchers have linked extrinsic approaches in the classroom to less complex learning (Deci, Koestner, & Ryan, 1999), less creativity, and less risk-taking behavior (Hennessey, 2000) on the part of students. Consistent with these findings, Senecal, Koestner, and Vallerand (1995) also found a positive correlation between extrinsic orientation and academic procrastination. In contrast, research has shown that intrinsically motivated students exhibit a desire for academic challenges (Reeve, 2006) and are likely to demonstrate academic exploration and creativity (Grolnick, Deci, & Ryan, 1997). They are also able to sustain attention in academic tasks (Deci & Ryan, 2000), which results in increased academic achievement (Boggiano, et al., 1993).

Despite research cautioning the long-term viability of incentivizing learning, educators have implemented token economies to maintain discipline and promote student achievement (Kohn, 1993; Lipe & Jung, 1971). In a study of 186 charter schools, Raymond (2008) reported that 57% instituted some type of incentive system to promote academic achievement. In an ambitious experimental study, Harvard economist Roland Fryer Jr. distributed \$6.3 million to 38,000 students in 261 schools in Chicago, Dallas, Washington D.C., and New York to bolster test scores (Freyer, 2010). Fryer (2010) reported that, although the incentives contributed to gains in compliant behavior and classroom performance, these increases did not correlate positively with standardized test scores.

Because of the prevalence of contingent rewards in the school setting, cognitive psychologists have attempted to evaluate their effect upon long-term intrinsic motivation (Deci, Koestner, & Ryan, 1999). Contingent rewards represent physical token

administered immediately, or a longer-term benefit tied to completion of an activity. Based upon the results of a meta-analysis of 128 experiments Deci, Koestner, and Ryan (1999) found that contingent rewards have an undermining impact upon long-term intrinsic motivation.

While the work of Deci, Koestner, and Ryan (1999, 2001) has strong support, it is not without controversy. Particularly relevant is the meta-analysis conducted by Cameron and Pierce (1994), who examined the same categories of rewards as those considered by Deci et al. (1999) and came to different conclusions. Specifically, Cameron and Pierce reported that rewards have no overall significant effect on intrinsic motivation for free-choice measures (returning to an activity without prompting during an experimental study). In addition, they found that rewards created significant enhancement of intrinsic motivation on self-report measures, and that verbal rewards significantly enhanced intrinsic motivation on both free-choice behavior and self-report measures (Cameron & Pierce, 1994). Based upon these findings, Cameron and Pierce advocated for the use of contingent rewards in the educational setting.

While Kohn's (1993) research found much support, particularly from advocates of self-determination theory (Deci & Ryan, 1985), it would seem that the approach advocated by Cameron and Pierce (1994) has won the day, considering the support of the current educational practitioners and policymakers. A visit into most elementary classrooms in the United States will show complex and pervasive token economies, complete with certificates, gold stars, and symbolic monetary compensation. Because contingent rewards and sanctions represent tried and true elements of the pedagogical toolbox of elementary teachers, problematizing this practice entails shifting scrutiny toward the long-term effects.

### Statement of the Problem

Considerable field experiments have shown the effects of contingent rewards on subsequent intrinsic motivation for engaging in proscribed activities, such as completing a puzzle or drawing (Deci, 1975; Lepper, Green, & Nisbett, 1973). While valuable on a theoretical level, such studies do not shed light on the motivational realities of the classroom environment, complete with student discipline, standardized curricula, and accountability measures. Although research has documented the use of praise and contingent rewards in the school setting (Kohn, 1993; Lipe & Jung, 1971; Raymond, 2008), there have been no accounts from the perspective of classroom teachers.

Researchers have shown that academic intrinsic motivation decreases from ages 9-18 (Eccles, Wigfield, Harold, & Blumenfeld, 1993; Gottfried & Gottfried, 1996, 2006; Harter, 1981; Lepper, Iyengar, & Corpus, 2005). Yet no research has examined the administration of incentives during the initial period of formal schooling (grades one through five), which lays the foundation for subsequent academic motivation. Because elementary school represents the student's initial exposure to the school system, the student internalizes the expectation of receiving rewards for academic activities, which are typically characterized as *work*. Although educational psychologists such as Dewey (2004, original work published 1916) and Piaget (1926, original work published 1923) have theorized that essential aspects of the personality are formed during the early elementary years, there has been little research documenting the extent to which elementary teachers incentivize instruction. Furthermore, elementary teachers have not been given the opportunity to articulate their justification for implementing the token economy and culture of rewards and sanctions (Kohn, 1993) which is ubiquitous in this setting.

### Purpose of the Study

The present study attempted to shed light onto systems of rewards and sanctions within the elementary classroom in grades one through five. Through the responses of elementary teachers, the study revealed a variety of motivational techniques, both positive and punitive in nature. The study sought to both quantify teachers' attitudes toward rewards and sanctions, and to provide descriptions of their implementation. While the descriptions of both school-wide and teacher-initiated systems of incentives provide a glimpse into the elementary classroom, the teachers' justifications for these approaches reflect a philosophy of education that has broad cultural implications. While this study is descriptive and exploratory in nature, it attempts to provide context for further research in an area of pressing concern that needs to be reclaimed.

### Theoretical Framework

Self-determination theory (Deci & Ryan, 1985) provides the lens through which I analyzed the data on rewards and sanctions. Building upon early work by Harlow (1950), Heider (1958), and DeCharms (1968), the theory focuses upon the quality of motivation and the extent to which the individual perceives himself or herself to initiate an action. Deci and Ryan (1985) defined motivation as "the energization and direction of behavior" (p. 3). By *energy*, they mean the needs that are either innate or acquired through environmental factors (Deci & Ryan, 1985). By *direction*, they mean the process by which these basic and acquired needs are satisfied (Deci & Ryan, 1985). On the surface, this sounds like a drive theory in the tradition of Hull (1943). However, the actions that are of most interest to Deci and Ryan are those outside the realm of survival drives. For example, they cite DeCharms' (1968) characterization of the human tendency to explore and alter the environment

for what appears to be its inherent enjoyment. Deci (1975) identified these activities as being intrinsically motivated. Such activities, according to Deci are “ones for which there is no apparent reward except the activity itself. People seem to engage in the activities for their own sake and not because they lead to an extrinsic reward” (Deci, 1975, p. 23). Much of the work of Deci and Ryan (1985) focuses on environmental and cultural factors that undermine intrinsic motivation and the process of internalization whereby extrinsic activities become part of the individual’s sense of self.

Within the context of self-determination theory, Deci and Ryan (1985) proposed the basic human needs of autonomy, competence, and relatedness. Deci, Vallerand, Pelletier, and Ryan, (1991) characterized these basic needs as feeling in control of actions (autonomy), expecting to meet performance goals (competence), and developing emotional connections with significant others (relatedness). Deci et al. indicated that individuals who experience autonomy, competence, and relatedness are self-determined to the extent that their acts are “fully endorsed” (p. 328) at the cognitive level. According to Deci (1975), intrinsically motivated activities are those in which people engage for their inherent enjoyment with no external reward or compulsion (Deci, 1975). Individuals with an intrinsic orientation experience psychological well-being and happiness (Deci & Ryan, 1985). According to Deci and Ryan, cultural factors, including education and parenting can foster or undermine intrinsic motivation.

While self-determination theory (Deci & Ryan, 1985) has been studied within the contexts of parenting (Garn, Matthews, & Jolly, 2010), competitive athletics (McAuley, Duncan, & Tammen 1989), psychology (Milyavskaya et al., 2009), weight loss (Kim, Deci, & Zuckerman, 2002), and health care (Ryan, Patrick, Deci, & Williams, 2008), it seems perfectly suited as a lens through which to view the incentivizing of education.

The theory provides the mechanism by which extrinsic motivators, though effective instructional practice in the short-run, undermine long-term interest in learning.

### **Research Questions**

The following questions guided the collection and analysis of data:

1. What school-wide and teacher-generated incentives do elementary schools have in place to enhance academic and behavioral outcomes of students?
2. How do elementary teachers implement and justify systems of rewards and sanctions in school?
3. How useful is self-determination theory (Ryan & Deci, 1985) in understanding systems rewards and sanctions in elementary classrooms?

### **Methodology and Design**

Quantitative survey results were supplemented by open-ended textual data to provide a contextual understanding of teachers’ practices and attitudes. Two hundred elementary teachers of grades one to five within a single school district in the Southern United States received links to Survey Monkey. Respondents included 105 teachers (53% response rate), representing a range of experience and grade levels. One hundred female and five male teachers completed five demographic items, two Likert-type items, and 11 open-ended questions, allowing the teachers to articulate and justify their use of systems of rewards and sanctions in the classroom.

### **Coding and Analysis**

I coded and organized data with an eye toward addressing the research questions through the lens of self-determination theory (Deci & Ryan, 1985). While limiting interpretation in the Presentation of Data, I organized the subsequent Analysis around the basic human needs of autonomy,

competence, and relatedness as postulated by Deci and Ryan (1985). Although I analyzed data through existing theory, I recognize my own role as both interpreter and judge of which textual items to include and which to leave. Therefore, I am mindful of Gadamer's assertion that "interpretation begins with fore-conceptions that are replaced by more suitable ones. This constant process of new projection constitutes the movement of understanding and interpretation" (1975, p. 269).

### Presentation of Data

Presentation of Data is divided into two sections, with the first being significantly shorter. It includes findings relating to two self-report items, along with brief quantitative analysis. This is followed by a more detailed qualitative section, which includes thematic subdivisions for different categories of rewards and sanctions. Although a formal Analysis section follows, I offer contextual analysis and clarification throughout the Presentation of Data.

### Quantitative Self-Report Items

To provide a general understanding of their attitudes toward the use of rewards and sanctions in the classroom, participants responded to two Likert-type items on a seven-point scale, with 7 indicating *very true*, 4 indicating *somewhat true*, and 1 indicating *not true at all*. By calculating the sum of responses of 7, 6, and 5 (all indicating a relatively high level of perceived truth), I was able to represent the level of teacher consensus. Table 1 indicates that the overwhelming majority of teachers (95%) have systems of rewards and consequences/sanctions.

Table 1:

*I implement a system of rewards and consequences regularly in my class. (7-point Likert scale)*

|               | Percentage | Count |
|---------------|------------|-------|
| 7 (Very true) | 66.3%      | 69    |

|                     |       |    |
|---------------------|-------|----|
| 6                   | 17.3% | 18 |
| 5                   | 11.5% | 12 |
| 4 (Somewhat true)   | 4.8%  | 5  |
| 3                   | 0%    | 0  |
| 2                   | 1%    | 1  |
| 1 (Not at all true) | 0%    | 0  |

|              |             |            |
|--------------|-------------|------------|
| <b>Total</b> | <b>100%</b> | <b>105</b> |
|--------------|-------------|------------|

Similarly, Table 2 indicates that 90% of participants felt that rewards and consequences are effective at the elementary level.

Table 2:

*I believe systems of rewards and consequences are effective with elementary students. (7-point Likert scale)*

|                     | Percentage  | Count      |
|---------------------|-------------|------------|
| 7 (Very true)       | 58.7%       | 61         |
| 6                   | 22.1%       | 23         |
| 5                   | 9.6%        | 10         |
| 4 (Somewhat true)   | 8.7%        | 9          |
| 3                   | 0%          | 0          |
| 2                   | 1%          | 1          |
| 1 (Not at all true) | 0%          | 0          |
| <b>Total</b>        | <b>100%</b> | <b>105</b> |

While demographic variables, including gender, grade level taught, and teaching experience were tested with respect to the two survey items on teacher attitudes toward rewards, no significant differences were found. Across gender, grade, and experience, respondents overwhelmingly supported the use of contingent rewards in the classroom, along with strong belief in their effectiveness.

### Qualitative Free-Response Items

While the two 7-point items revealed a general understanding of teachers' attitudes towards rewards and consequences, 11 open-ended questions allowed teachers to detail their systems of group and individual incentives, along with their application of

consequences for inappropriate behavior. The management systems spanned both the students' behavioral and academic outcomes throughout the school day, including both district-wide initiatives and teacher-created approaches. Teachers revealed highly developed token economies that covered nearly all of the students' time in school. Through the teachers' written responses, details of their application of praise and systems of incentives and punishments emerged, along with justifications, both pragmatic and philosophical in nature. The presentation of qualitative data is divided into seven major sections, including the school-wide incentive system, teacher-initiated token reinforcement, teacher-initiated tangible rewards, and privileges as incentives, responsibilities as incentives, color-coding behavioral plan, and recess as currency.

*School-Wide Incentive System.*

Central to the teachers' written descriptions of their use of incentives was their implementation of a district-wide system. All of the 105 participants described their unique application of this program, along with practical insights that only experienced practitioners could supply. One teacher outlined the [School Token] system:

[School Tokens] are given for doing their classroom jobs and in every group activity. Group completion for each lesson and the group that wins in the lesson gets a [School Token] individually in their [School Token] bank. Teacher opens the little store for them to buy toys or other little items with their [School Tokens]. Whole group students are given tickets for big activities like assemblies or field trips and have a small raffle for the day.

From the above description, it seems that students have specific "jobs" which must be performed to earn some type compensation. The teacher spoke in economic terms,

creating a "bank" to stockpile students' [School Tokens], and a "store" where transactions occur.

Another teacher provided additional details on the program, with emphasis upon the color-coding system:

If they misbehave they get their ticket taken away and cannot participate in the raffle. Consequences are no rewards and color change if they keep misbehaving, depending on warnings. Color change leads to time off recess and I keep adding time if it continues.

Still another teacher described how the [School Tokens] are tied to sticks, stickers, and stamps, representing a tangible currency to foster a range of student behaviors:

Students are paid [School Tokens] each week for attendance. They are deducted [School Tokens] for each stick pulled, and miscellaneous management behavior (i.e. no homework, needing extra copies of assignments, not bringing books, etc.). Additionally, I have used sticker/stamp charts to reinforce positive behaviors, passing them out when students are exhibiting those traits I desire in students, and they can exchange full cards for a trip to the prize box or extra [School Tokens].

Another teacher clarified how the school-wide behavioral policy is connected to documentation and parental communication:

School-wide, our campus implements a Behavior Policy. We have six specific rules, and each one is a different color. Students that break rules must "pull at Stick" of that color. Behavior issues are documented on calendars and taken

home daily in folders to be signed by parents.

### *Teacher-Initiated Token Reinforcements*

According to the teacher participants, although the school-wide token system is a district-mandated policy, they still had a range of options concerning implementation. In fact, most teachers expanded substantially on the original program, adding a range token reinforcements. One teacher described this practice, stating “When we fill our marble jar up for total classroom behavior or get a complement from another teacher, we have a party: pizza, ice cream etc.” According to the teachers, these delayed rewards can be tied to student conduct or academic activities, such as reading books. Another teacher mentioned a visual aid for tracking class behavior, noting “We use the ‘caught you being good chart’ for large group. If they collect so many stars, they earn a class lunch or party.” Some of the token systems represent the performance of small groups or tables of students. One teacher noted “We keep track of table behavior with ‘Sparklers,’ if a table earns five sparklers they can choose an intrinsic reward.” Although the teacher did not clarify what she meant by “intrinsic reward,” one would assume that the group would be afforded some choice of activities.

Although some of the aforementioned systems of tokens applied to the actions of individual students, most represented large-group incentives, typically tied to citizenship behaviors. For example, one teacher explained that “if the entire class earns 20 days of not pulling a stick, I will personally give them an ice cream party after lunch.” Presenting a similar approach, a teacher linked class behavior to reading, stating “When the entire class has gone all day with zero codes we have a popcorn party while we read for pleasure.”

### *Teacher-Initiated Tangible Rewards*

While teachers described various systems of tracking behavior linked to indirect tokens, they also clarified the specific rewards that students eventually receive. These tangible rewards can be divided into two categories, including physical objects and food. The physical objects could be best described as trinkets, such as stickers or stamps. Several have some connection to academics, such as bookmarks or erasers. While the food items represent a range of options, some teachers stressed the need for “healthy treats.”

Table 3 illustrates a sampling of the contingent rewards according to the aforementioned categories.

Table 3:

*Contingent Rewards in the form of Physical Objects and Food Referenced by Participating Teachers*

| <u>Physical Objects</u>  | <u>Food</u>    |
|--------------------------|----------------|
| Marbles                  | Pizza          |
| Sparklers                | Ice cream      |
| Sticks                   | Crackers       |
| Gems                     | Jelly beans    |
| Clips                    | Healthy treats |
| Tickets for treasure box | Skittles       |
| Pirates' gold            | Gum            |
| Token money for store    | Popsicles      |
| Raffle tickets           | Popcorn        |
| Erasers                  |                |
| Bubbles                  |                |
| Happy faces              |                |
| Stamps                   |                |
| Toys from Kids' Meals    |                |
| Folders                  |                |
| Bookmarks                |                |
| Gift certificates        |                |
| Stickers                 |                |

### *Privileges as Incentive*

Just as teachers described their distribution of token and tangible rewards, they also detailed how they offered students choices and special privileges, contingent upon academic achievement and acceptable behavior. Several teachers described granting well-behaved students the chance to “sit in the teacher’s chair for a day,” “sit by



the teacher at lunch,” or “sit by a friend at lunch.” They also afforded students the right to “choose a quiet spot in the room with a blanket or carpet square and read quietly during assigned reading times as opposed to remaining at their desk.” Teachers also spoke of awarding “free dress days” for appropriate behavior and successful completion of academic tasks. Another teacher mentioned using free homework passes and “no starters for a week [warm-up activities]” as incentives for successful academic performance. One teacher justified the system of incentivizing with privileges, noting “They get paid every week for their attendance, behavior, and doing their job.”

#### *Responsibilities as Incentives*

In addition to privileges, the elementary teachers made frequent reference to the practice of offering individual students additional responsibilities as compensation for appropriate behavior. One teacher explained, “If there is one particular student who is showing good behavior, I let them be my line leader, or take messages where they need to go.” Another provided additional details on specific responsibilities that she affords students:

I let students who are behaving well be my helpers. They love to help. I will let them deliver things to other teachers, turn the lights on/off, hold things for me, etc. I use this a lot. I'll even say “I'm looking for a helper in line to hold our headphone basket . . .” And most of them will straighten right up in line because they want to help!

Other teachers mentioned special jobs, including line leader, floor specialist, and snack helper. They also rewarded students by allowing them to grade papers, read to the class, help with the weekly calendar, sharpen pencils, turn off the lights, close the doors, and serve as table or bathroom monitors. One teacher reported an extrinsic approach to

student motivation, explaining “The students that show consistent positive behavior get to do jobs around the classroom to earn more [School Tokens]. The students love to help out, especially if they get paid for it.” She went to point out how she supplements the School Token approach with the imposition of physical exercise, additional tangible rewards, curricular choices, and food:

When I need to provide discipline for the entire class, I may use laps around the playground, stickers, center time, or even on occasion one Skittle. I do not use a treasure jar. I really try to move students intrinsically rather than extrinsically; but they are only five years old.

Teachers clarified that the offer of responsibilities and special duties was always contingent on good behavior. Thus, the prospect of losing that responsibility loomed over the students, both individually and as a group. Table 4 illustrates a sampling of the privileges and responsibilities, as mentioned by the participating teachers.

Table 4:

#### *Contingent Rewards in the form of Privileges and Responsibilities Referenced by Participating Teachers*

| <u>Privileges</u>     | <u>Responsibilities</u> |
|-----------------------|-------------------------|
| Choices:              | Teacher helper          |
| Seat                  | Team captain            |
| Work center           | Pencil sharpener        |
| Partner in activity   | Door monitor            |
| 10 minute free choice | Light monitor           |
| General free time     | Table monitor           |
| Clothing:             | Read to class           |
| Pajama day            | Snack helper            |
| No shoes day          | Floor specialist        |
| Hat day               | Paper grader            |
| Play:                 | Errand runner           |
| Board games           | Helper with             |
| calendar              |                         |
| Learning puzzles      |                         |

Longer recess

Food:

- Snack break
- Eat with teacher
- Picnic lunch

Academics:

- No homework pass
- Computer time
- Free reading
- Free study time
- Free drawing time
- Extra writing time
- Library time
- Music while working
- Special speaker
- Movies
- Select reading
- Pillow time during reading

Use of classroom space:

- Couch time
- Chair time
- Sit by teacher
- Sit on floor

Social:

- Quietly talking
- Extra time to socialize

First student:

- To lunch
- To stations

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Just as teachers detailed the use of incentives to encourage appropriate student behavior, they also described systems of consequences for inappropriate conduct. Teachers uniformly reported using color coding behavior plans as a way to visually represent the performance of their classes. They also demonstrated strong support of using recess as a currency for group behavior.

#### *Color coding behavior plan*

One teacher explained her chart for behavior, noting “As a second grade team, we utilize a color system. Students start each day on green and move to yellow, orange, and red for misbehavior. We do not allow students to move back to green.” She went on to explain that she implements “a whole group smiley/frowny system where the class, as a whole, earns tally marks under smilies or frownies for group behavior. Compliments

from other teachers earn smilies, as well.” Another teacher clarified specific infractions in the behavioral code, stating “We have a color system and I try to have the rule of not getting out of your seat without permission and no talking without raising your hand.”

Typical of the teachers’ coding plans was a punitive approach to behavior management, with clear consequences for noncompliance. One teacher explained:

I use a code sheet to manage behavior. If the students are not following instructions, or are demonstrating poor behavior choices, they receive a code. If they reach five codes, they are sent to the office, and phone calls are made to parents.

While most teachers advocated a mix between incentive systems and imposed consequences, two suggested that the punitive approach should not apply to the class as a whole. One teacher explained her position, stating “I don’t believe in punishing a whole class for one person’s actions unless the whole class has made bad choices; I still assign negative consequences individually.” Another echoed her remarks, noting “I generally don’t give group consequences. The only exception being when my class as a whole gets too rowdy, too loud, I have them put their heads down for a few minutes.”

#### *Recess as currency*

In addition to detailing their color coding behavior systems, teachers expressed the overwhelming consensus that recess can be used as an effective incentive or consequence for student behavior. One teacher described a type of recess calculation:

For the whole class, we have a point system. If they are off task, loud, or not following directions, I get a point. If they are doing the right thing, they get a point. At the end of the week, if they have more points,

they get to go outside an extra time.  
If I have more points, we come in  
from recess 10 minutes earlier.

Another indicated that she imposed specific activities during recess, including “taking laps around the playground . . . for poor conduct.” Other teachers described requiring students to “spend time walking during recess,” based upon the color coding system. A teacher explained how she used recess as a central behavioral tool:

As a whole, students earn recess daily. I write the word RECESS on the board, and if the class gets too out of control they lose a letter. If they lose all the letters, the whole class has to sit out during recess.

The teachers’ comments indicated a willingness to leverage social pressure in the form of group incentives and consequences to obtain student compliance, both academically and behaviorally.

### **Analysis**

As I read the participating teachers’ accounts of systems of rewards and consequences, I was first struck by the uniformity of their views. All of the 105 participants implemented the district-wide incentive system and offered personalized versions, with a range of tokens and currency to modify student behavior and academic output. While their solid support for incentivized instruction may not be surprising, their nuanced descriptions of these systems, along with philosophical justifications for the practice, provide a context for a broader discussion of educational motivation. The following analysis is organized by the three basic needs of autonomy, competence, and relatedness, as described by Deci and Ryan (1985) with respect to self-determination theory.

#### **Autonomy**

Reeve (2006) argued that the imposition of contingent rewards undermines autonomous learning on the part of students. He framed this view in terms of increased teacher control, which results in relatively fewer student choices, and a teacher-centered classroom environment (Reeve, 2006). In the present study, teachers were happy to relate the intricacies of their programs of incentives and sanctions, describing a clear power structure, where the teachers bestowed a range of rewards to their students. The teachers also held additional desirable outcomes, such as special privileges or recess, over the heads of the group. In many cases, teachers described elaborate coding systems, tracking the groups’ progress, particularly with respect to behavioral outcomes. In fact, the teachers expressed their practice of periodically updating students on their progress, referencing the reward, along with specific behaviors that move students closer or farther from this desired outcome.

Common to many of the student rewards was the idea of choice. In the case of recess, students had the opportunity to engage in relatively unencumbered play, making an array of choices with minimal adult direction. They also offered students choices of apparel, seating, and activities, contingent upon appropriate behavior and successful academic progress. It is not surprising that activities driven by choice would be of particular value to students. Many teachers in the study related that such *currency* was the only means at their disposal to successfully manage their classroom.

Eisenberger, Pierce, and Cameron (1999) argued that contingent rewards can communicate a task’s importance, which has a positive effect upon intrinsic motivation. Conversely, Kohn (1993) suggested that the imposition of a reward reflected the message that the activity was not of inherent value; only the activity’s instrumental value would be meaningful to students. The findings of the current study seem to support Kohn’s view, particularly with respect to student

autonomy. The group of teacher participants frequently referred to school as “work,” for which students needed to be compensated. Although the students have the opportunity to autonomously navigate the system of token rewards and engage in *shopping* to spend their [School Tokens], they have also received constant communication of contingencies and technical aspects of the coding system which permeates the school environment. Reading into the teacher statements, the implied message is that the inherent interest in the subject matter is trumped by *how well* the students do, particularly within the realm of the incentive system. The public application of rewards and sanctions, often in the form of full-group incentives, implies a school-wide system of control. Within this incentivized environment, students encounter controlling teaching practices, which profoundly limit autonomous, self-endorsed learning (Deci, Koestner, & Ryan, 1999).

### Competence

Closely related to autonomy is the concept of perceived competence, where students develop an understanding of success with respect to academic output. According to Deci and Ryan (1985), perceived competence can be viewed as a predictor of intrinsic motivation. Since the systems of incentives described by the participating teachers represent a ubiquitous feedback loop, one could argue that it fosters feelings of competence. Particularly for individual rewards, students may gain feelings of self-efficacy with respect to both academic and behavioral outcomes. Deci and Ryan (1985) posit that verbal feedback can be interpreted as either controlling or autonomy-supportive by students. With that in mind, the students’ perception of competence may be moderated by the quality of that feedback. As in most teaching situations, the delivery and tone of the feedback may be especially important.

Particularly salient to a student’s perceived competence is the extent to which the learning activities are optimally

challenging (Csikszentmihalyi, 1997). In the current study, teachers described the practice of “catching a student doing well.” In many instances, students received positive feedback and tangible rewards for merely behaving in a normal and expected fashion. Rewarding a student for quietly standing in line without causing a disturbance is qualitatively different from providing a tangible reward for solving a difficult math problem.

### Relatedness

According to the teacher participants, a common practice of behavioral management was to “catch a student behaving well,” and to make this fact know to the entire class. By leveraging a student’s feeling of belonging in a group, teachers wield a powerful tool of classroom management. According to Deci and Ryan (1985), seeking a sense of belonging to a group represents a basic human need, which is foundational for subsequent intrinsic motivation. Based upon the teacher comments, systems of competitive rewards were common for all ages of children. In fact, awards assemblies with recognition of achievement, often in the form of [School Tokens] was typical practice at all campuses.

This public display of rewards represents an attempt to heighten the competitive aspect of the behavioral program. In a summary of research, Deci and Ryan (1985) stated that “competitively contingent rewards are the most controlling” (p. 81). This aligns with Kohn’s (2004) point that teachers often create distrust between students when they promote competition within the classroom. By placing contingencies on relatedness, the teachers risk the fragile sense of belonging which is a prerequisite to intrinsic motivation.

Beyond pitting students against each other to compete for scarce rewards, the elementary teachers reported frequent dependence upon their most prized currency: recess. Teachers revealed elaborate color coding schemes that provided students with constant reminders of their progress toward

“earning” recess. Although a few teachers spoke against the practice of group rewards and punishments, most indicated a willingness to take full advantage of the students’ desire for free play. Teachers referenced recess as the most potent power present in their disciplinary toolbox, perfectly suited to modify student behavior. Because recess represents a group reward/consequence, well-behaved students are often at the mercy of their less compliant colleagues. While student-level data would be required to understand the scope of this phenomenon, the teachers’ comments indicate a disposition toward short-term expediency over potential long-term effects.

### **Limitations and Future Research**

Although the data come from a single school district, one would expect similar accounts in most classrooms across the United States. Future research could expand the sample to a range of public and private schools. In addition, it would be instructive to consider incentives throughout the entire k-12 spectrum, focusing on the qualitatively different forms that emerge at the high school level. One could also gain meaningful insight into the phenomenon by observing the incentive systems in action within an elementary classroom, paying particular attention to the level of autonomy-support vs. control exhibited by teachers. Research could also uncover the motivational link between the home and school by studying parental incentives (payment for satisfactory report cards, books read, etc.). On a broader scale, it would be instructive to learn the extent to which heightened incentivizing of education represents a peculiarly American phenomenon. One could compare levels of educational incentives in various countries, such as Germany, Japan, and China, who have high-stakes summative assessments similar to those in the United States. Finally, research should explore alternative approaches, such as Montessori, where teachers apply informational, rather than evaluative feedback and minimize the

imposition of rewards for learning (Montessori, 1912).

### **Conclusion and Implications**

While the present study was exploratory in nature, it confirmed many suspicions that I had about incentive structure present in the elementary classroom. Although substantial research from the past four decades has shown the unintended consequences of extrinsic motivators in the educational setting (Deci, Koestner, & Ryan, 1999), teachers persist in implementing sophisticated incentive systems to ensure behavioral compliance and maximize academic outcomes. While clearly encouraged by school administrators, the extent to which this practice is supported by colleges of education is beyond the scope of this study. I have explained the motivation of the teachers in terms of the increased emphasis on results of high-stakes testing (Kohn, 1993; Popham, 2001). While that explanation is satisfactory, it does not align with calls for creating life-long learners.

I would argue that the teachers’ approach does not originate from inadequate understanding of child development, nor from lack of willingness to align instruction to research on student motivation. In fact, the comments of the elementary teachers revealed an acute awareness of student development, particularly in the area of character. Teachers spoke of the benefits of affording students privileges and responsibilities, contingent upon compliance with classroom rules. Yet, in spite of their focus on development, they engage in large-scale incentivizing of learning. It is likely that teachers are responding in a predictable manner to their own pressures to produce measurable student growth (Flink, Boggiano, & Barret, 1990; Pelletier & Sharp, 2009). This aligns with Campbell (1976), who stated “The more any quantitative indicator is used for social decision-making, the more subject it will be to corruption pressures and the more apt it will be to distort and corrupt the social processes it is intended to monitor”

(p. 49). If you read *high-stakes testing* as the *quantitative indicator*, it follows that we are seeing those *corruption pressures* in action, through teaching to the test, narrowing the curriculum, and incentivizing learning.

Perhaps most troubling aspect of the teachers' responses was that they did not make the distinction between type of activities for which they imposed rewards and sanctions. Rather, they freely offered up rewards for both enjoyable and non-enjoyable student behavior. By providing the same type of incentives for pleasurable and unpleasant activities, the teachers send confusing signals to children, who may come to doubt the value of any activity (such as learning) to which one attaches a reward (Kohn, 1993).

I view the current research as an attempt to reclaim an old question in education. Kohn (1993) presented exhaustive and compelling evidence that teachers should proceed with caution when offering praise, rewards, and consequences to students. He expanded our understanding of incentives, suggesting a cultural phenomenon that included schools, the workplace, and the home. Perhaps the only effective strategy to push back against such overwhelming forces would be to link the absence of incentives (intrinsic motivation) to student achievement (standardized testing). Kohn would appreciate the irony.

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**Abstract**

This study explores the relationships between uniform policies and school outcomes by analyzing data from the School Survey on Crime and Safety 2007-2008. Data from 387 urban elementary schools indicate that schools with uniform policies tend to have more violent incidents than schools without uniform policies. Perceptions of principals indicate more frequent incidents (e.g., verbal abuse of teacher, disrespect to teacher, and classroom disorder) in schools with uniform policies than schools with no uniform policies. In addition, school violence measured by disciplinary outcomes shows that schools with uniform policies have more drug problems, physical attacks or fights, insubordination, gang-related incidents, and disruptions than schools without uniform policies. After controlling for school characteristics and school violence, multivariate regression analyses show that schools with uniform policies are positively associated with achievement and learning value, but negatively with students' aspiration.

During the last 10 years, there has been an increasing rate of public schools mandating a uniform policy. According to a recent report from the U.S. Department of Education (Robers, Zhang & Truman, 2012), about 19% of public schools required students to wear a uniform in the 2009-2010 school year, compared to the 1999-2000 school year when only 12% of public schools had uniform policies. Although more schools have adopted school uniform policies, the benefits have rarely been confirmed by empirical evidence. Proponents of uniform policies claim that uniform policies reduce problem behaviors, improve achievements, minimize the socioeconomic gap, and create a more orderly learning climate; however, others disagree (Anderson 2002; Evans 1996; Johnston 2009; Wilken 2012; Zernike 2002).

Many researchers have examined the effects of uniform policies on student outcomes such as attendance (Brunsma & Rockquemore 1998; Hughes 2006; Stockton & Gullatt 2002), achievement (Brunsma & Rockquemore 1998; Draa 2005; Yeung 2009), school climate (Brunsma & Rockquemore 1998; Huss 2007; Murray 1997), and student behaviors (Brunsma & Rockquemore 1998;

Han 2010; Johnson 2010; Polacheck 1996; Sanchez, Yoxsimer, & Hill 2012). By analyzing nationally representative samples, the current study attempts to add another piece of empirical evidence to determine how uniform policies influence the school outcomes. A few studies have simultaneously examined multiple types of student outcomes including violence, academic achievement, and educational motivation, which may be the most predictable benefits from uniform policies. The main purpose of the study is to seek associations between uniform policies and school outcomes in the hopes that the findings result in a better understanding of uniform policies' effects. The present study controls for ten potential factors (e.g., parental involvement, proportion of minority students, school violence and crime in school areas) that may influence associations between school uniform policies and school outcomes. By doing so, the results could minimize an overestimation of the effects of uniform policies on the school outcomes.

## Literature Review

### Uniform Policies and Violence

Reducing students' problem behaviors is one of the strong claims of proponents of uniform policies. Prior studies have demonstrated negative effects of uniform policies on violence, yet the findings are rather inconsistent (Brunsma & Rockquemore 1998; Draa 2005; Han 2010; Hughes 2006; Polacheck 1996; Wade & Stafford 2003; Yeung 2009).

Researchers have found negative associations between uniform policies and violence at different school levels (middle or high school); urban area; and perceptions of various stakeholders, such as principals, parents, students, and teachers. A study of the Long Beach Unified School District in California examined the first implementation of uniform policies in U.S. public schools. The case clearly showed that a uniform policy was effective in reducing violent incidents (Polacheck 1996). In this study, uniform policies were implemented for approximately 60,000 students in 70 schools during the years 1993-1994 and 1994-1995. Overall, violent incidents were reduced about 35%, from 3,242 to 2,074, during the period.

Similarly, Draa (2005) found a significant reduction in the suspension rate over time in 64 urban high schools in Ohio. Furthermore, Wade and Stafford (2003) conducted a survey of 415 students and 83 teachers and reported a significant decrease in gang presence in six urban middle schools. In addition, Texas middle schools reported a decrease in students' problem behaviors and discipline outcomes (Hughes 2006) and a middle school in Nevada also reported a decrease in discipline outcomes and students' perceived violent incidents, such as gang and bullying problems (Sanchez et al., 2012). Han (2010), even after controlled for crime prevention efforts, the achievement level on standardized tests and school size, demonstrated negative relationships between uniform policies and a number of student

problem behaviors (e.g., weapons, drugs, alcohol, fights) at the elementary and middle school levels.

Contrary to those studies, a national study showed no such effect of uniform policies. Brunsma and Rockquemore (1998), who analyzed a nationally representative sample from the National Educational Longitudinal Study of 1988 (NELS: 88), found no direct associations between uniform policies and student problem behaviors (e.g., suspension, fights, being in trouble, and substance use), holding school characteristics and school preparedness and attitudes constant. On the other hand, Wade and Stafford (2003) showed mixed results of the effect of uniform policies by different stakeholders. Based on data from six public urban middle schools, the researchers found that students' perceptions of gang presence did not change with uniform policies, but the teachers in schools requiring uniform policies perceived less gang presence than their counterparts (Wade & Stafford 2003). Similarly, Johnson (2010), based on data from 38 high schools in North Carolina from the 2004-2005 through 2008-2009 school years, found no significant change in violent incidents and suspensions after schools adopted uniform policies. However, the school administrators from those schools perceived an increase in school safety. Huss (2007) also found that elementary school teachers perceived a positive effect of uniform policies on school order and discipline, yet only suspensions decreased and the actual number of discipline referrals remained unchanged.

### Uniform Policies and School Outcomes

Although proponents of uniform policies believe that uniforms improve student academic performance (e.g., achievement, graduation rate, and attendance rate), only a few studies provide firm empirical evidence for this claim.

Schools having mandatory uniform policies improved attendance and graduation rates in urban high schools in Ohio (Draa 2005) and raised the attendance rate in secondary schools in a large urban school district (Gentile & Imberman 2012). Yet other national studies failed to show such positive effects. In Brunsmma and Rockquemore's (1998) study, the result of regression analyses using more than 4,500 samples from NELS:88 showed negative associations between uniform policies and standardized achievement scores. For tenth graders in schools adopting uniform policies, a 3-point decrease in standardized test scores was observed. In addition, Brunsmma and Rockquemore reported no direct effect of uniform policies on attendance rates (Brunsmma & Rockquemore 1998). Another national study also failed to demonstrate that a uniform policy increases academic achievement. Using two nationally representative data sets, the Early Childhood Longitudinal Study, Kindergarten Class (ECLS-K) and the NELS:88, Yeung (2009) measured students' achievement using multiple subjects and examined the association between school uniforms and achievement among second and tenth graders. In his study, no significant association between uniform policy and achievement was found, after controlling for previous achievement level (Yeung 2009).

While no significant effect of uniform policies on attendance rates was reported in two middle schools in Texas during the 1995-1996 school year (Hughes 2006), positive effects of uniform policies on student achievement and attendance rate were observed in Louisiana (Stockton & Gullatt 2002). There was a positive effect on student achievement at the middle and secondary schools, but only the secondary schools reported improvement in attendance rates (Stockton & Gullatt 2002).

Another strong claim from uniform proponents is that uniforms create a sound learning climate, yet there is very weak

evidence as well as inconsistent research findings.

Murray (1997) conducted a survey of 306 students in two middle schools to determine the effects of uniform policies on school climate. School climate was measured with 10 subitems, such as the students' academic orientations, students' behavioral values, and relationships with teachers and peers. Comparing the means of the responses, Murray found higher means for the school climate items (9 out of 10 subitems) in uniform schools than in non-uniform schools. Although Murray indicated differences in students' perceptions of school climate between uniform schools and non-uniform schools, no statistical tests were performed in the study. Huss (2007), conducting an interview of six elementary school teachers in Ohio, found a positive effect of uniform policies on school climate. Interview results indicated that uniform policies promote respect, trust, and a caring environment by decreasing clothing-related discrimination toward students in poverty. In addition, the teachers perceived that school order, discipline, and students' academic motivation, such as doing homework and participating in class, improved (Huss 2007).

Even though some previous studies have demonstrated the benefits of having uniform policies, others showed no such findings. Wade and Stafford (2003) performed a multivariate analysis of variance using data from 415 students and 83 teachers in urban middle schools and there was no significant difference in students' self-perceptions between uniform schools and non-uniform schools. Moreover, students with uniforms had lower scores in the self-worth test than those without uniforms. Additionally, students' and teachers' responses to perceived school climate (e.g., teacher-student relationships, student-peer relationships, and security and maintenance) were not statistically different with uniform policies in place (Wade & Stafford 2003).

controlling for school characteristics and school violence?

### Current Study

Using a nationally representative sample, the current study investigated relationships between uniform policies and school outcomes. One possible reason for the inconsistent results of the previous studies is that the adequate control variables were not considered. Failing to do so may have caused an overestimation of the effects of uniform policies. The current study controlled for necessary confounding factors such as school size, percentage of disadvantaged students (e.g., ethnic minority, limited English proficient [LEP] students, and special education students), parental involvement, and crime level in the school area and students' residence. The results may increase accuracy in determining whether or not a uniform policy influences in the achievements, aspirations, and learning values. The present study used data from only public elementary schools, because the school sector and the school level may influence the effects of uniform policies on student outcomes (Brunsma & Rockquemore 1998). Finally, many previous studies assessed perceptions of student problem behaviors (Huss 2007; Johnson 2010; Sanchez et al., 2012; Wade & Stafford 2003) and showed contradictory findings across stakeholders. To improve the method of measurement of violence, the present study used both the principals' perceived violence, the number of students who committed offenses based on official school records, and number of violent incidents measured by disciplinary actions.

Specific research questions of the study are as follows. First, are the principals' perceptions of school violence in uniform schools significantly different from that of non-uniform schools? Second, are actual violent incidents in uniform schools significantly different than those in non-uniform schools? And third, how are uniform policies associated with school outcomes, after

### Method

#### Data

The School Survey on Crime and Safety (SSOCS) is one of the most comprehensive data sets that contains information about school crime and safety, including crime prevention programs, school security practices, and student problem behaviors with disciplinary actions. The SSOCS program was established by the National Center for Education Statistics (NCES) to meet the need in ensuring safe, high-quality education in the wake of multiple school shootings in 1999. On behalf of the U.S. Department of Education, the NCES developed the 2007-2008 SSOCS and the U.S. Census Bureau conducted the survey. During February 25 and June 17 in 2008, a total 3,367 of questionnaire packets were sent to public elementary, middle, high, and combined schools. A total of 2,560 usable questionnaires were collected and 77.2% was obtained as a weighted response rate (Ruddy, Neiman, Hryczaniuk, Thomas, & Parmer 2010). As a nationally representative data set, SSOCS has been collected every 2 years since the 1999-2000 school year and the SSOCS 2007-2008 data, which was used in the current study, is the latest that has been released to the public. In the present study, 387 elementary schools in urban areas were selected from the SSOCS 2007-2008 data set.

#### Variables

Uniform policies were measured whether or not schools required uniforms and used it as a dichotomous variable (yes = 1, no = 0). In addition, uniform policies and uniform schools both mean schools that require students to wear uniforms in the study. School violence for the multiple regression models was measured by using the total number of students who committed offenses based on schools' official records. Achievement,

aspiration, and learning value were measured based on principals' report. Achievement was measured as the percentage of students who scored above the 15th percentile on standardized tests. Aspiration was measured by the percentage of students who were likely to go to college after graduating high school. Learning value was assessed by the percentage of students who perceived the importance of academic achievement.

Principals' perceived school violence was measured by eight forms of school violence including student racial/ethnic tensions, bullying, sexual harassment, disorder in classrooms, verbal abuse of teachers, disrespect towards teachers, gang activities, and cult or extremist group activities. Principals responded to each item as 1 = happens daily, 2 = happens at least once a week, 3 = happens at least once a month, 4 = happens on occasion, and 5 = never happens. This variable was reverse-coded for the analysis.

Actual violent incidents for the second research question were assessed as number of disciplinary actions for each firearms, weapons, drugs, alcohol, physical attacks or fights, insubordination, gang-related hate crimes and classroom disruption.

Parental involvement in school events was measured using four items (e.g., open house and parent-teacher conferences) and obtained the following responses: 1 = 0% to 25%, 2 = 26% to 50%, 3 = 51% to 75%, 4 = 76% to 100%, and 5 = school does not offer. For the analyses, response 5 (school does not offer) was excluded and the sum was computed as a composite of parental involvement in school events (Cronbach's  $\alpha = .76$ ). Parental involvement in discipline was assessed using three items (i.e., formal process of parental input on crime and discipline policies, training for dealing with student problem behavior, and involvement in discipline) and the alpha coefficient for the three items was .52.

School size was assessed as a categorical variable indicating 1 = less than 300, 2 = 300 to 499, 3 = 500 to 999, and 4 = greater than 1,000. Minority students were defined as Black/African American, Hispanic/Latino, Asian, Native Hawaiian/Other Pacific Islander, and American Indian/Alaska Native, and they were assessed as a percentage of the categorical variable (1 = less than 5%, 2 = 5% to less than 20%, 3 = 20% to less than 50%, and 4 = 50% or more). Special education students were measured as a percentage and were categorized as students who have disabilities or other needs for special education and related services under the Individuals with Disabilities Education Act (IDEA). The LEP students were measured as a percentage based on principals' reports. High-crime in school location was assessed as 1 = high level of crime, 2 = moderate level of crime, and 3 = low level of crime. It was created as a dummy variable indicating a high level of crime. High-crime in student residence was assessed as 1 = high level of crime, 2 = moderate level of crime, 3 = low level of crime, and 4 = students come from areas with very different levels of crime. For the analysis, excluding item 4 (students come from areas with very different levels of crime), a dummy variable indicating a high level of crime was created.

### **Data Analyses**

The independent samples t-test was performed to answer the first research question (Are the principals' perceptions of school violence in uniform schools significantly different from that of non-uniform schools?) and the second research question (Are actual violent incidents in uniform schools significantly different than those in non-uniform schools?). The third research question (How are uniform policies associated with school outcomes (e.g., academic achievement, aspiration, and learning value, after controlling for school characteristics and school violence?) was answered by using multivariate regression

analyses. In the multivariate regression analyses, 10 control variables were included: parental involvement in school events, parental involvement in discipline, school size, minority student, special education students, LEP students, perceived school violence, school violence, high-crime in school location, and high-crime in students' residence. School violence in the multiple regression model showed a positively skewed distribution, so this variable was transformed using log 10 for the multivariate regression analyses. To detect multicollinearity, the average Variation Inflation Factor (VIF) of regression models was examined. The results showed that the VIF of each variable ranged from 1.03 to 3.10, and the average VIF was 1.70. Multicollinearity is considered when values of VIF are greater than 10 (Field 2009), thus it was concluded that none of the variables in the multiple regression models were highly correlated with others. All analyses were performed with SPSS 17.0, and the weighted data (FINALWGT variable) that were provided by the SSOCS data set were used.

## Results

### Principals' Perceived School Violence between Uniform and Non-Uniform Schools

Table 1 (See Appendix) displays the results of independent samples t-test indicating whether a principal's perceived school violence differs between uniform schools and non-uniform schools. The findings show that uniform schools have more frequent violent incidents than non-uniform schools. Four out of eight forms of school violence (e.g., verbal abuse of teacher, disrespect to teacher, classroom disorder and gang activities) occur more frequently in uniform school than non-uniform schools. Students' verbal abuse of teachers in uniform schools ( $M = 1.04$ ,  $SD = .99$ ) is more frequent than in non-uniform schools ( $M = .61$ ,  $SD = .68$ ). The results of this test indicate that there is a statistically significant difference in students' verbal abuse of teachers between the schools with/without a uniform policy,  $t(385) = 4.91$ ,  $p = .000$ . The

size of the effect as indexed by Cohen's coefficient  $d = .51$ , which is medium. Students' disrespectfulness towards teachers is more frequent in uniform schools ( $M = 1.28$ ,  $SD = 1.14$ ) than in non-uniform schools ( $M = .86$ ,  $SD = .82$ ) with  $t(385) = 3.74$ ,  $p = .000$ . The effect size of Cohen's  $d$  is .39, which is small. Classroom disorder is more frequent in uniform schools ( $M = .68$ ,  $SD = 1.02$ ) than in non-uniform schools ( $M = .31$ ,  $SD = .62$ ) with  $t(385) = 4.36$ ,  $p = .000$ . The effect size of Cohen's  $d$  is .44. Gang activity is more frequent in uniform schools ( $M = .28$ ,  $SD = .58$ ) than in non-uniform schools ( $M = .13$ ,  $SD = .37$ ) with  $t(385) = 2.46$ ,  $p = .014$ . The effect size of Cohen's  $d$  is .23.

### Actual Violent Incidents between Uniform and Non-Uniform Schools

Table 2 (See Appendix) shows how the mean number of violent incidents is different between uniform schools and non-uniform schools. All eight forms of incidents occur more frequently in uniform schools than in non-uniform schools. Specifically, uniform schools have a statistically significantly more drug-related incidents than non-uniform schools ( $M = .09$  vs.  $.01$ ;  $t = -2.84$ ,  $p = .005$ ). The effect size of Cohen's  $d$  is -.30. Uniform schools have more incidents involving physical attacks or fights than non-uniform schools ( $M = 14.03$  vs.  $8.98$ ;  $t = -2.02$ ,  $p = .044$ ). The effect size of Cohen's  $d$  is -.21. Students' insubordination incidents occur more frequently in uniform schools than in non-uniform schools ( $M = 29.52$  vs.  $13.43$ ;  $t = -2.12$ ,  $p = .034$ ). The effect size of Cohen's  $d$  is -.22. Gang-related incidents and hate crimes occur more frequently in uniform schools than in non-uniform schools ( $M = .69$  vs.  $.09$ ;  $t = -2.90$ ,  $p = .004$ ). The effect size of Cohen's  $d$  is -.30. The disruption incidents occur more often in uniform schools than in non-uniform schools ( $M = .70$  vs.  $.42$ ;  $t = -2.63$ ,  $p = .009$ ). The effect size of Cohen's  $d$  is -.27.

### Effect of Uniform Policies on School Outcomes

Table 3 (See Appendix) presents relationships between uniform policies and school outcomes including academic achievement, aspiration and learning value. After controlling for school characteristics and school violence, uniform policies may improve the mean achievement score measured by standardized tests ( $p < .001$ ) and positively influence students' learning value ( $p < .001$ ), but they may negatively influence students' aspiration. The results of multivariate regression model indicate that the proportions of variation in school outcomes explained by all school variables is .30 for achievement ( $p < .001$ ), .34 for aspiration ( $p < .001$ ) and .27 for learning value ( $p < .001$ ). According to the model, the percentage of students who are above 15 percentile on standardized tests is predicted as 90.68% for non-uniform schools and 95.28% for uniform schools, respectively. The percentage of students who are likely to go to college after high school is predicted as 38.18% for non-uniform schools and 35.98% for uniform schools. The percentage of students who value academic achievement is predicted as 49.35% for non-uniform schools and 52.48% for uniform schools.

Additionally, principals' perceptions of school violence, actual school violence measured by number of students who committed in offenses and high-crime in school area show negative relationships with achievement, aspiration, and learning value ( $p < .001$ ).

### **Discussion**

This study explored whether or not uniform policies have positive influences on school safety and school outcomes. Analyzed data of 387 urban elementary schools from SSOCS 2007-2008 had results from the current study as follows.

First, the results of the study do not support that uniform policies contribute to creating a safer school. School principals in uniform schools perceived that classroom

disorder and school violence (e.g., verbal abuse of teacher, disrespect to teacher, classroom disorder and gang activities) occurred more frequently than their counterparts in non-uniform schools. Interestingly, principals in uniform schools perceived more violent incidents between students and teachers rather than between students. There could be potential conflicts between students and school staff in uniform schools, because students seem to view uniform policies as restricting their freedom of expression and may not believe in the benefits of the policies (DaCosta, 2006). It is recommended that principals reconsider when they adopt uniform policies as an alternative means of promoting an orderly learning environment. At the same time, the current findings based on the cross-sectional study were not able to determine a cause and effect among the variables, thus future studies should further examine whether having a uniform policy causes conflicts between students and school staff, and if such conflicts lead a school or school district to adopt a uniform policy. Regarding school violence measured by official school records also showed that drug-related incidents, physical fights and attacks, insubordination, gang-related incidents and other disruptions occurred more frequently in uniform schools than in non-uniform schools. Urban elementary school principals should be aware that adopting uniform policies might not be the answer in increasing school safety.

Second, the results of the study support the idea that uniform policies positively influence academic achievement and learning value among urban elementary school students. This is an inconsistent result from previous studies. Brunsma and Rockquemore (1998) found that uniform policies decrease achievement in 10<sup>th</sup> graders and Yeung (2009) found no significant relationships between uniform policies and achievement in 2<sup>nd</sup> and 10<sup>th</sup> graders. Such mixed results could be caused by the use of different analysis strategies, different control variables, and students' grades and school locations. Based on the findings of the present

study, urban elementary schools may have benefits from adopting uniform policies with an increase in achievement and improved learning value among students.

Third, the results of the study do not support that adopting uniform policies tends to positively influence students' aspiration. It is understandable that students prefer not to wear uniforms and tend to be against uniform policies, especially when schools start mandating uniforms without the students' input on the policy (DaCosta, 2006). Such a circumstance may develop negative school experiences and negatively affect students' intrinsic motivation for further schooling. Principals in urban elementary schools should be aware that uniform policies may discourage students' future learning motivation.

In conclusion, the study provides little evidence of the effects of school uniforms on creating a safer school and promoting aspiration among urban elementary school students, yet shows that school uniforms may increase academic achievement and students' learning value.

### Study Limitations

Although this study highlights the value of using a nationally representative sample with multiple control variables to explore the benefits of school uniform policies, several cautionary notes should be applied to the findings. The SSOCS data used in the study were based on responses at one point in time in 2008 and therefore constitutes a cross-sectional data set. The relationships among the variables cannot be determined as a cause and effect. This study relied on school principals' reports, and lacks the insights of other stakeholders (e.g., teachers, parents, and students). Finally, the public-use of SSOCS data does not provide information on lunch status. This study included parental involvement and information on crime level in the school area and student's residence instead, yet those variables may not fully measure the socioeconomic status.

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Appendix

Table1

*Principals' Perceived School Violence in Uniform Schools and Non-Uniform Schools*

|                                  |                     | N   | M    | S.D. | 95% CI for Mean Difference | t       |
|----------------------------------|---------------------|-----|------|------|----------------------------|---------|
| Racial/ethnic tensions           | Non-uniform schools | 113 | .65  | .71  | -.10, .22                  | .70     |
|                                  | Uniform schools     | 274 | .71  | .81  |                            |         |
| Bullying                         | Non-uniform schools | 113 | 1.65 | .96  | -.05, .39                  | 1.52    |
|                                  | Uniform schools     | 274 | 1.82 | 1.07 |                            |         |
| Sexual harassment                | Non-uniform schools | 113 | .61  | .62  | -.06, .22                  | 1.08    |
|                                  | Uniform schools     | 274 | .69  | .68  |                            |         |
| Verbal abuse of teacher          | Non-uniform schools | 113 | .61  | .68  | .26, .60                   | 4.91*** |
|                                  | Uniform schools     | 274 | 1.04 | .99  |                            |         |
| Disorder in classroom            | Non-uniform schools | 113 | .31  | .62  | .20, .54                   | 4.36*** |
|                                  | Uniform schools     | 274 | .68  | 1.02 |                            |         |
| Disrespect for teacher           | Non-uniform schools | 113 | .86  | .82  | .18, .59                   | 3.73*   |
|                                  | Uniform schools     | 274 | 1.25 | 1.14 |                            |         |
| Gang activities                  | Non-uniform schools | 113 | .13  | .37  | .02, .22                   | 2.46*   |
|                                  | Uniform schools     | 274 | .25  | .58  |                            |         |
| Cult or extreme group activities | Non-uniform schools | 113 | .01  | .12  | -.04, .01                  | -1.29   |
|                                  | Uniform schools     | 274 | .00  | .00  |                            |         |

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

Note. df = 385

Table 2

*School Violence in Uniform Schools and Non-Uniform Schools*

| School violence                                   | Uniform policy      | N   | Mean  | S.D.  | 95% CI for Mean Difference | t        |
|---|---------------------|-----|-------|-------|----------------------------|----------|
| Firearm or explosive device                       | Non-uniform schools | 274 | .22   | 2.73  | -.59, .52                  | -.13     |
|   | Uniform schools     | 113 | .26   | 1.96  |                            |          |
| A weapon other than a firearm or explosive device | Non-uniform schools | 274 | .35   | 1.13  | -.49, .10                  | -1.29    |
|   | Uniform schools     | 113 | .54   | 1.75  |                            |          |
| Drugs   | Non-uniform schools | 274 | .01   | .09   | -.14, -.03                 | -2.84*** |
|   | Uniform schools     | 113 | .09   | .45   |                            |          |
| Alcohol   | Non-uniform schools | 274 | .05   | .38   | -.08, .08                  | -.05     |
|   | Uniform schools     | 113 | .05   | .32   |                            |          |
| Physical attacks or fights                        | Non-uniform schools | 274 | 8.98  | 20.29 | -9.96, -.13                | -2.02**  |
|   | Uniform schools     | 113 | 14.03 | 26.68 |                            |          |
| Insubordination                                   | Non-uniform schools | 274 | 13.43 | 64.60 | -30.98, -1.19              | -2.12**  |
|   | Uniform schools     | 113 | 29.52 | 74.95 |                            |          |
| Gang-related and hate crimes                      | Non-uniform schools | 274 | .09   | .50   | -1.00, -.19                | -2.90*** |
|   | Uniform schools     | 113 | .69   | 3.32  |                            |          |
| Disruptions                                       | Non-uniform schools | 274 | .42   | .90   | -.49, -.07                 | -2.63*   |
|   | Uniform schools     | 113 | .70   | 1.10  |                            |          |

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

Note. df = 385

Table 3

*Relationships Between Uniform Policies and Educational Outcomes*

|                                 | Achievement     | Aspiration     | Learning value  |
|---------------------------------|-----------------|----------------|-----------------|
|                                 | B (SE)          | B (SE)         | B (SE)          |
| Uniform policies                | 4.60*** (.29)   | -2.22*** (.44) | 3.13*** (.41)   |
| PI in school event              | 2.35*** (.20)   | 13.35*** (.30) | 11.24*** (.28)  |
| PI in discipline                | -0.24* (.11)    | 1.71*** (.17)  | 1.47*** (.15)   |
| LEP students                    | -0.08** (.01)   | -0.23*** (.01) | -0.10*** (.01)  |
| Special education Student       | 0.08*** (.01)   | -0.34*** (.01) | 0.06*** (.01)   |
| Minority students               | -1.77*** (.17)  | -3.44*** (.26) | -0.70** (.24)   |
| School size                     | 1.90*** (.14)   | 1.45*** (.21)  | 0.56** (.20)    |
| Perceived school violence       | -4.58*** (.26)  | -6.49*** (.39) | -5.10*** (.37)  |
| School violence                 | -5.41*** (.20)  | -1.62*** (.30) | -4.72*** (.28)  |
| High-crime in school location   | -10.81*** (.52) | -3.60*** (.79) | -13.05*** (.73) |
| High-crime in student residence | -4.54*** (.49)  | -.73 (.75)     | 1.43* (.69)     |
| N                               | 387             | 387            | 387             |
| Adjusted R <sup>2</sup>         | .30             | .34            | .27             |

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

*Note.* PI refers to parental involvement; LEP refers to limited English proficient students

**A. Louise Perkins***University of Southern Mississippi***Abstract**

In this paper we discuss educational pedagogy vis-à-vis its impact on preparing students for careers in engineering. We relate their learning needs to the field of Educational Psychology by defining this focus group in terms of IQ metrics and relate these metrics to child development theory. We point out where we believe the current educational system is failing them. We then present a vertical study that follows eight students from 1st through 5th grade, emphasizing the improvements gained between third and fifth grade after the new approach was used. The traditional pedagogy was used in grades 1-4, while the suggested changes were incorporated in grade 5.

**Introduction**

On September 2, 1958, the United States passed the National Defense Education Act to increase the number of students pursuing careers in science and mathematics. The initial push, through the 1960's, was modestly successful. Since 1969, however, steady declines have put our nation at risk (Cofield, 2010). After reform, we now prepare significantly less students for science, technology, engineering and math (STEM) careers than we did in 1958. Currently New Zealand, Australia, Japan, and even Iran continue to perform significantly higher on international assessment metrics. While many students remain interested in STEM majors in college, a significant number change their majors, mostly due to failing grades (EOS Vol. 94 No. 37 Sept. 2012 NEWS). In 1983 the national commission on excellence in education [i.e. *A Nation at Risk*] concluded that the US is

“being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people....For the first time in the history of our country, the educational skills of one generation will not equal, will not even approach, those of their parents.”

In the [World Economic Forum] they assessed the state of US education in 1983, noting that

- compared with other industrialized nations, US education never places first, and frequently places last,
- tens of millions of American adults are functionally illiterate,
- average achievement test scores have declined for nearly half a century - science showed a steady decline for the 15 years preceding the study,
- more than 50% of gifted students do not achieve their projected ability,
- fully one third of 17-year-olds lack critical thinking skills, and cannot make reasonable conclusions from written material while fully two thirds cannot solve multi-step mathematics problems, and
- collegiate graduate achievement tests show a marked decline.

There is a “nearly desperate need for increased support for the teaching of mathematics and science ... declines in educational performance are in large part the result of *disturbing inadequacies in the way the educational process itself is often conducted.*”[*A Nation At Risk*] (emphasis added). A more recent report, (Schwab,

2011) indicates that the decline has continued into the twenty-first century.

In (Spellings, 2005) they relate the state of post-secondary education to the secondary educational system as follows: "Several national studies confirm the insufficient preparation of high school graduates for either college-level work or the changing needs of the workforce. Dismal high school achievement rates nationwide have barely budged in the last decade. Close to 25 percent of all students in public high schools do not graduate." US mathematics and science rankings are clustered with less developed countries such as Kenya, despite half a century of effort.

The US is not the only country concerned with declining science and engineering graduation rates. Australia and England, despite placing significantly higher in international rankings, are also facing declining enrollment in science and mathematics. None of the reforms that have been tried over the past several decades has been able to reverse the participation trend (Noorden, 2008).

### **Underfunding Gifted Education**

Our rankings in science and mathematics are far lower than countries that focus their educational efforts towards future Engineers and Scientists. In the United States an opposite focus exists. Our Government mandates specific levels of special education. When resources decline, the states' obligations to provide a minimum level of support for students significantly below normal intelligence levels, in conjunction with their need to balance their budgets, frequently requires underfunding gifted education which is not mandated by the federal government.

The US economy is far stronger than our K-12 rankings merit. The World Economic Forum's data offers an explanation for this dichotomy (Schwab, 2011). The US ranks third in the world for attracting talented people as workers. This skill extends to attracting talented college students from

around the world. While the US ranks 50th for secondary education quality, we rank 6th for College education quality. US High School math and science education rankings are dead last of the industrialized countries, yet our colleges graduate some of the best engineers and scientists. Our K-12 STEM educational programs have failed, and US Engineering disciplines are being kept alive by borrowing brain power from other nations.

### **Focus on Engineering**

In this paper we focus on the population of elementary students who have the potential to become engineers. We explain how and where we believe the current educational system is failing them. To support this belief we present a grade 1-5 vertical study, following eight students. All eight students attended a highly regarded Kindergarten program, and were very prepared for first grade. These students then used the Chicago math pedagogy from 1st through 4<sup>th</sup> grade, taught by certified elementary education teachers, and then had a 5th grade math class taught by a scientist who followed a pedagogy not un-like the interactions Richard Feynman describes occurring with his father when he was a child. Today we would say they are curiosity-driven, inquiry-based studies that are *technically correct and mathematically rigorous*.

Our vertical study is not large enough to be conclusive. Rather, combined with the scientists voices from the California Curriculum commission, strengthens the merit of their recommendations.

The overall K-12 pedagogy studies are directed towards students falling within one standard deviation of the norm ( $84 < IQ < 116$ ). In addition there are persistent albeit inconsistent efforts directed towards individuals two or more standard deviations away from the norm in the positive direction ( $IQ > 132$ ). These populations are well studied (c.f. the publications of C. Tomlinson).

This leaves 13.5% of our population, those that lie between one and two standard

deviations away from the norm in the positive direction ( $116 < IQ < 132$ ), underserved. Table 1 lists average IQ's for different fields, where we see that such students are, on average, significantly equipped to enter traditional STEM disciplines.

|     |                         |
|-----|-------------------------|
| 130 | Physics                 |
| 129 | Mathematics             |
| 129 | Computer Science        |
| 128 | Economics               |
| 127 | Chemical Engineering    |
| 127 | Material Science        |
| 126 | Electrical Engineering  |
| 126 | Mechanical Engineering  |
| 125 | Philosophy              |
| 124 | Chemistry               |
| 123 | Earth Sciences          |
| 122 | Industrial Engineering  |
| 122 | Civil Engineering       |
| 121 | Biology                 |
| 120 | English/Literature      |
| 120 | Religion/Theology       |
| 120 | Political Science       |
| 120 | History                 |
| 118 | Art history             |
| 118 | Anthropology/archeology |
| 116 | Architecture            |
| 116 | Business                |
| 115 | Sociology               |
| 114 | Psychology              |
| 114 | Medicine                |
| 112 | Communication           |
| 109 | Education               |
| 106 | Public Administration   |

Table 1: Average IQ for various Professions. Notice that the professions from 116-130 are employing individuals with an IQ between one and two standard deviations above the norm.

The US educational pedagogies in place today are not serving these potential Engineering majors, those with average IQ's between 122-130, are not a primary focus in K-12 educational institutions - research articles on this population were difficult to locate. This vertical study,

therefore, adds one data point focused on this particular population.

## Analysis

An examination of math and science textbooks before and after the 1960's shows an obvious shift. The earlier texts are significantly shorter, and include the development of very narrow topics one physical or mathematical example at a time (cf. (Faraday, 1861)). They focus on the subtle details of the science and the critical thinking needed to correctly assemble these details into a mental model – they do not attempt to entertain the reader but rather engage their curiosity to deeply understand the subtleties of the topic. For example, Faraday's book, written at the end of the 1800's, walks the reader through the subject as if they were an apprentice, rather than as if they were students in a lecture class. One can follow and confirm his results with a series of experiments that can be performed independently with very few resources, and then understand the explanations he presents, *without having to read an excessive amount of information in textual form*. In contrast, most current education is classroom based and the textbooks, aiming for Universality, include significant textual information.

## Discrete vs. Continuous Subjects

Math and science courses are fundamentally different than English and History courses. English and Social Studies may be viewed as continuum courses, while other subjects, such as mathematics, are taught as discrete classes. Continuum classes are typically text-based. They focus on students with normal to superior IQ who are good with non-mathematical critical thinking skills (verbal reasoning). In the US success in continuous courses with language-based support has improved over the last half century (Glatthorn, 1987) for some fields. These same reforms have been added to US



discrete subject courses, but have failed to stop the continuing qualitative and quantitative reasoning declines in courses that require a quantitative reasoning skill sets.

In order to improve discrete subject courses, where language-based pedagogical approaches are currently failing, we propose two paradigm shifts. First, re-focus our efforts *in these classrooms only* towards the student population more likely to enter those professions (rather than our current focus on keeping uninterested students from becoming bored (Feynman)). The current math and science curriculum could be differentiated allowing students with aptitude and/or interest to pursue a parallel course of study more directed towards the engineering and science professions, with less language-based descriptions and more hands-on and critical thinking work. A course, in short, designed for those who have IQ's between 1 and 2 standard deviations above the norm, who are superior in quantitative reasoning, but who may not be as talented and/or interested in text-based methodologies.

Our second proposal is motivated by the thinking presented in [1] by Cofield and Popkin who emphasize that "the key challenge to implementing good teaching practices is ... have physicists teaching physics". In Asian countries, being a STEM teacher is considered one of the best jobs in the country (Gentile, 2012). To communicate a subject, the speaker needs to be both passionate about and a master of that subject.

### **Richard Feynman vs. the State of California**

In 1964 the Nobel laureate physicist Dr. Feynman served on the Curriculum Commission for the state of California (they adopt textbooks). He included some of the details in his book "Surely You're Joking, Mr. Feynman!". I have shortened the chapter in which he decries this experience, but I use his own words to let the reader see his displeasure with the educational reform efforts at that time and with their associated pedagogy. Italics have been added for emphasis. The excerpt is

rather lengthy, but its message is seminal to our argument as the vertical study follows a teacher who emulated his conversations with his father as a way to teach and motivate similarly aged young people.

... the [text]books were so lousy. They were false. They were hurried. They would try to be rigorous, but they would use examples which were almost OK, but in which there were always some subtleties. The definitions weren't accurate. Everything was a little bit ambiguous -- they weren't smart enough to understand what was meant by "rigor." They were faking it. *They were teaching something they didn't understand*, and which was, in fact, useless, at that time, for the child. .... Anyhow, I'm looking at all these books, all these books, and none of them has said anything about using arithmetic in science ...

Finally I come to a book that says, "We will give you an example from astronomy"... "Red stars have a temperature of four thousand degrees, yellow stars have a temperature of five thousand degrees . . ." -- so far, so good. It continues: "Green stars have a temperature of seven thousand degrees, blue stars have a temperature of ten thousand degrees, and violet stars have a temperature of . . . (some big number)." *There are no green or violet stars*, but the figures for the others are roughly correct. It's vaguely right -- but already, trouble! That's the way everything was: Everything was written by somebody who didn't know what the hell he was talking about, so it was a little bit wrong, always! And *how we are going to teach well by*

*using books written by people who don't quite understand what they're talking about, ...* Then comes the list of problems. It says, "John and his father go out to look at the stars. John sees two blue stars and a red star. His father sees a green star, a violet star, and two yellow stars. What is the total temperature of the stars seen by John and his father?" -- and I would explode in horror ... it was perpetually like that. Perpetual absurdity! There's no purpose whatsoever in adding the temperature of two stars. Nobody ever does that ... It was awful! All it was was a game to get you to add, and they didn't understand what they were talking about. It was like reading sentences with a few typographical errors, and then suddenly a whole sentence is written backwards. The mathematics was like that. Just hopeless!

... What finally clinched it, and made me ultimately resign, was that the following year we were going to discuss science books. I thought maybe the science would be different, so I looked at a few of them ... there was a book that started out with four pictures: first there was a windup toy; then there was an automobile; then there was a boy riding a bicycle; then there was something else. And underneath each picture it said, "What makes it go?"

I thought, "I know what it is: They're going to talk about mechanics, how the springs work inside the toy; about chemistry, how the engine of the automobile works; and biology, about how the muscles work." ... The answer was, for the wind-up toy,

"Energy makes it go." And for the boy on the bicycle, "Energy makes it go." For everything, "Energy makes it go."

Now that doesn't mean anything ... It's also not even true that "energy makes it go," because if it stops, you could say, "energy makes it stop" just as well. ... Energy is neither increased nor decreased in these examples; it's just changed from one form to another ...

But that's the way all the books were: They said things that were useless, mixed-up, ambiguous, confusing, and partially incorrect. *How anybody can learn science from these books, I don't know, because it's not science.* “

This last decade, the state of California decided to try and include scientists a second time (THE MATH WARS - Implementing Standards: The California Mathematics Textbook Debacle, 2012). This experience is chronicled in the book (Wilson, 2003). She explains the tendencies for math educators to be biased toward the progressive school of mathematics education, and the working scientists to be biased towards a more traditional view of math education, clearly and impartially. The same problems arose, and the Nobel prize winners (there were more than one the second time) quit the commission in protest-- as did Feynman -- before the textbooks were adopted. When the scientists and the educators can't agree, we must not expect to succeed at educating scientists.

### **Discrete Subject Differences**

To bring a math student to the level of understanding of the present topic necessary to advance to the follow-on abstraction, a rudimentary mastering of the previous concepts is necessary, but not sufficient. For example, counting comes before addition and addition before multiplication. For each new

concept any deficiency in background knowledge makes it difficult for students to advance. Hence deficiencies must be reviewed at each step until the preliminary concepts are at least weakly present in their minds while they learn the more advanced topic. This is the nature of math and science and the fundamental reason why the subjects are presented as discrete topics.

### Educational Psychology

A teacher who is also a competent mathematician understands the dependencies within the discrete subjects and can recognize where a student's misconceptions are, and begin to correct these misconceptions as they build towards the next topic. Relevant repetition problems assigned the night before a new topic also prepares the students to bridge over to the next abstraction. Further, when teaching an abstraction fails, you can retrench, correct their mental models of the task at hand, and then try the more abstract approach again.

Piaget proposed, without proof, that there is a maturity level, a threshold if you will, when the normative child is mentally capable of advancing beyond hands-on-learning to begin learning new concepts in a more formal manner. This maturity level is correlated to both age and IQ. Lower IQ individuals may be unable to master an abstract concept regardless of age, while higher IQ individuals may notice many abstract connections on their own. Indeed this is the germ of theory from which the Intelligence Quota was constructed.

In (Wikipedia, 2012), the developers of the IQ test were measuring ability to learn memory, attention and verbal skills by adulthood based on differential age acquisition in childhood. Only 6 out of the original set of 30 questions were mathematical in nature. However today's tests have an equal number of verbal and mathematical questions, and most questions require some logical thinking. An aggregate breakdown of abilities is given in Table 2.

| Score   | Original Name        | Modern Name   |
|---------|----------------------|---------------|
| >140    | Genius               | Near-Genius   |
| 120-139 | Very Superior        | Very Superior |
| 110-119 | Superior             | Superior      |
| 90-109  | Average              | Normal        |
| 80-89   | Dull                 | Dull          |
| 70-79   | Borderline Deficient | Deficient     |
| 50-69   | Moron                | Moderate      |
| 20-49   | Imbecile             | Severe        |
| 0-19    | Idiot                | Profound      |

Table 2: IQ Chart.

Current IQ tests measure cognitive abilities as they relate to both qualitative and quantitative reasoning, problem solving and discovering existing relationships. These are the critical thinking skills that make a good Engineer (c.f. (National Association of Secondary School Principals, 1980)(Jones, 1998)).

IQ has been defined as

$$IQ = \left( \frac{\text{Mental Age}}{\text{Actual Age}} \right) * 100,$$

which centers the Gaussian distribution of both quantitative and qualitative skills about the mean at 100 (Current studies show a wide disparity across countries, however, that is unaccounted for in this theory (webpage)).

### Constructivist Learning

Following the Constructivism learning theory, we can view teaching as passing your mental schemes onto others. The difference between passing on information (data) and schemes (knowledge) is profound. Teachers may focus on presenting the scheme itself, or

on designing a path that others may follow to arrive at a scheme similar to the one they have constructed in their own mind. To teach STEM well, as Feynman noted, these mental schemes need to be valid (correct). STEM teachers need to understand the details of the scheme's mental model. Unfortunately, the educational reforms of the past half century focused on the path (ex. manipulatives), without realizing that the average class room teacher (with an IQ of 109) did not possess sufficient mental models. In this void, students are left to develop their own schemes. Working within a void, students with higher IQ's may construct a mixture of correct and incorrect mental models, leading to frustration and doubt, which reduces, rather than increases, the potential pool of Engineering students. This may explain why more than half of the gifted students in the US do not reach their full potential.

The law of large numbers (Tanis) argues that a Gaussian distribution applies to the four phases of Piaget's psychological development theory (c.f. (Han, 2001)) The four phases are shown in Table 3 with the positive standard deviation mental ages listed as well.

| Stage          | Physical Age or $ \sigma  < 1$ | $1 < \sigma < 2$ | $2 < \sigma < 3$ | $\sigma > 3$ |
|----------------|--------------------------------|------------------|------------------|--------------|
| Sensorimotor   | 0-2                            | 0-1.75           | 0-1.5            | 0-1.3        |
| Preoperational | 2-7                            | 1.75-6           | 1.5-5.4          | 1.3-4.8      |
| Concrete Op.   | 7-11                           | 6-10             | 5.4-9            | 4.8-8        |
| Formal Op.     | 11-adult                       | 10-adult         | 9-adult          | 8-adult      |

Table 3: Piaget's Psychological Development Theory

Approximately 68% of individuals lie within these stages at the given ages.

The normative intelligence range is between 84-116. We would expect this cluster of individuals to track Piaget's phases more closely, and those outside this region to deviate from this structure as shown in Table 3.

Individual's two standard deviations above the norm, those 5% with an averaged IQ of over 130, are well studied. They are able to answer questions posed to test the higher phases of Piaget's mental development earlier than their peers by the definition of IQ.

Individuals above three standard deviations, above 148, are far from the average, and it is unclear whether the same developmental stages should apply to them since behavior above three standard deviations may well indicate different dynamics are dominating. Differentiated instruction (Differentiated Instruction, 2012) researchers make the case that students placed in academic settings based on their mental age (a concept introduced in 1912), rather than their physical age, perform better overall.

An optimal educational pedagogy, then, would include assessment feedback that informs the instructor as to when a student is transitioning to new levels of thought. Then, as appropriate, a switch can be made to a more formal method of instruction. Educational research efforts directed towards ways to identify these paradigm shifts, rather than studying the disparate pedagogies that have demonstrably failed, may prove useful. This is especially promising since educational research indicates that students learn best when placed by their mental rather than physical age.

### Vertical Study

We present a vertical study of eight students who were in 1-5<sup>th</sup> grade from 2001-2006 along the Gulf of Mexico coast. These students shared the same teachers for five years, used the same textbooks, and had the

same classes. The sample size is small as many students did not return after hurricane Katrina (Pat Smith).

From grades 1-4, the math courses utilized the Chicago math curriculum [10], however almost all of the student's parents complained that their children were not learning math well during the fourth grade year (interview with School Principal). This is backed up by the standardized test scores, which show that at the end of first grade six of the eight students scored at or above 98%, yet by third grade only one did. The average percentile fell from 92% to 72% - a full 20 percentage points in just two years. The Chicago math approach vertically integrates manipulatives, while eschewing practicing the fundamental tasks. This is analogous to teaching reading by spending most of their classroom and homework exploring all the words where the letter "A" makes a hard sound. Reading research shows [11, 12] that omitting the practice of studying words, in favor of theoretical foundational studies, does not produce good readers. But the opposite is also true. For reading, then, a combination of practice and phonemes (theoretical underpinning's) works remarkably well. For mathematics, an analogous blend of practice and abstraction was introduced during the students fifth grade year in order to focus on the transition between concrete and formal operations that typically occur near that age.

We include all data available from 1-5<sup>th</sup> grade assessments because it demonstrates that the overall downward trend in second through fourth grade was reversed when the new pedagogy was introduced. We include national standardized test results for verbal reasoning, reading comprehension, writing mechanics, writing concepts, and quantitative reasoning as well as math in this study.

We note that these students' fifth grade year was very challenging because most students lived in temporary cramped residences or in a neighbor's side yard after a catastrophic natural disaster destroyed their community.

## **Data Analysis**

At the beginning of their 5<sup>th</sup> grade year, their school was heavily damaged in Hurricane Katrina, and 6 of the students lost their homes. Both resources and teachers were hard to find. For several months after the storm the class teacher emphasized writing mechanics, and the class wrote and published a book about the Hurricane [Vissar et al.]. Their fifth grade math teacher did not return after the storm, so a PhD Computer Scientist volunteered to help. The class did not include mathematics for two months after the storm. Both teachers were very enthusiastic about their subjects, and both were highly competent. Each had clear mental models of their subjects (Personal Interviews).

Six skill areas were measured using National Standardized testing at the end of the students first, third and fifth grades. Some areas were not tested all three years, and a few student reports were lost in the storm. The areas measured were

- Verbal Reasoning
- Reading Comprehension
- Writing Mechanics
- Writing Concepts
- Quantitative Reasoning
- Math

We discuss the trends in these test results focusing on the difference between their third and fifth year measures. In reading comprehension (Fig. 1) the overall trend was downwards. Four students decreased performance over 8 percentage points, while three increased an average of 6 percent.

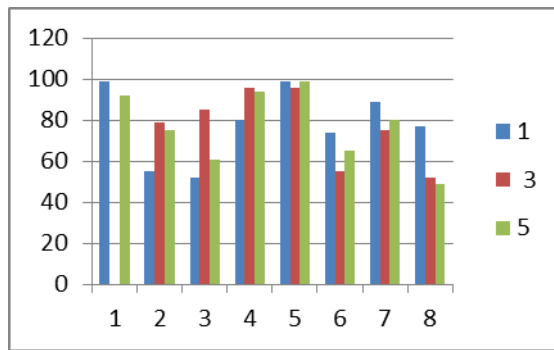


Figure 1: Overall downward trends in reading comprehension from 3rd to 5th grade, with first grade scores shown for reference (-4 -24 -2 +3 +10 +5 -3). Increasing students added 18 points, while decreasing students lost 33 points.

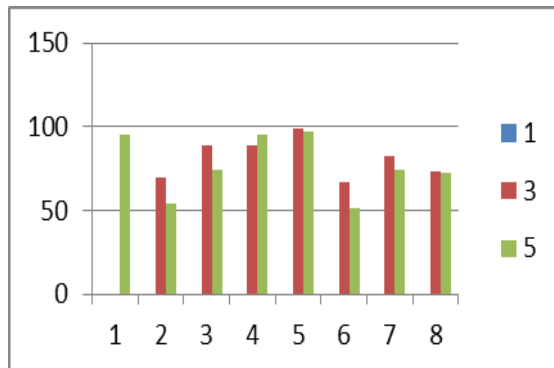


Figure 2: Nearly universal downward trend in writing concepts (3rd to 5th grades) (---16 -15 +6 -2 -16 -8 -1). Only one student improved, while six students lost ground.

The second measure, writing concepts, showed marked declines. Only one student improved, and the average decline was 6.5% (Fig. 2).

The third metric was the classroom teacher's passion (Fig. 3). A previous class of hers had won the annual national Scholastic book competition. So for the first two months after the hurricane, with no facilities available, the teacher met with the students in her own home, whenever they could, and they wrote a book about the storm and how it changed their lives (Vissar, 2006). Here 5 students improved an average of 22.8% while two

students declined an average of 15%. Student 6 declined in four out of the six areas measured, showing significant declines in many areas. The student was homeless for a significant amount of time during the school year, and was strongly affected by the storm (interview with the principal).

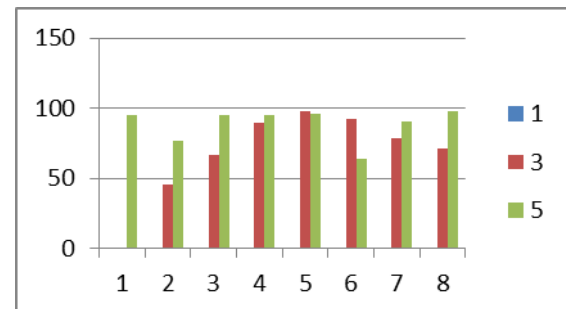


Figure 3: Trends in writing mechanics (3rd to 5th) (-- +31 +28 +5 -2 -28 +12 +27). Six of the eight students performed above the 90% even though only three had done so after third grade. All students performed above the 60%. Five students improved adding 103 percentage points total, while two decreased losing 30 percentage points.

In Mathematics (Fig. 4) most students responded well to the scientist/teacher. Student three, however, showed no interest in the subject. She slept during class, did not turn in homework, etc... Overall she was an excellent student, and the teaching staff never gave up on her, but at the end of the year they concluded that she was electing not to focus on math. She showed the largest decline in Math. Of the remaining students, two thirds scored at or better than after their third grade.

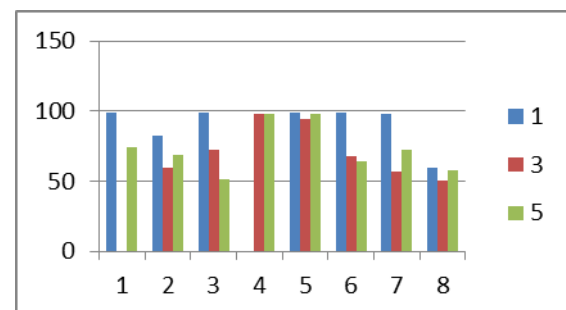


Figure 4: Math demonstrates an overall upward trend from third to fifth grade, ( $-- +9 - 21 -- +4 -4 +15 +8$ ). Because the overall trend from first grade to third was significantly downward, Data Imputation methods argue that student 1 probably improved from third grade as well, even though that data was not available. Four students improved for a total of 36 percentage points, while two students continued to lose ground with a total of 25 lost percentage points.

In the next metric, quantitative reasoning, students showed remarkable gains in critical thinking with numbers (Fig. 5). The Math teacher focused on how to approach problems using math to reason out a solution. Five students showed an average improvement of 13.6%, while two students declined an average of 8%.

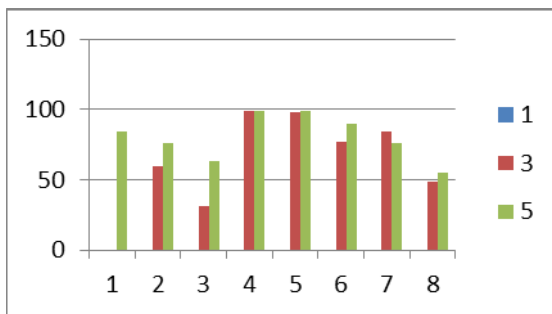


Figure 5. Quantitative reasoning includes the transition from hands on to abstract thought ( $-- +16 +32 -- +1 +13 -8 +6$ ). Working explicitly on this transition helped students significantly improve.

Five students improved in their verbal reasoning skills as well (Fig. 6). The five students who increased, added 68 percentage points, while the one student who decreased dropped 8 points.

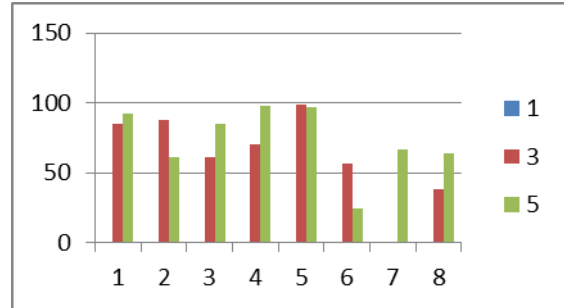


Figure 6: Trends in verbal reasoning (3rd to 5th) ( $+7 -27 +24 +28 -2 -32 -- +26$ ). Four students increased a total of 85 points, while 3 students lost 61 percentage points.

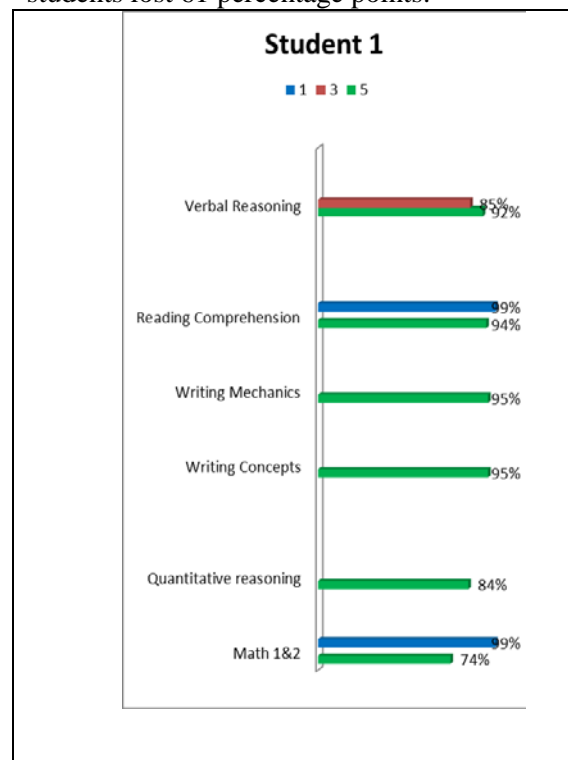
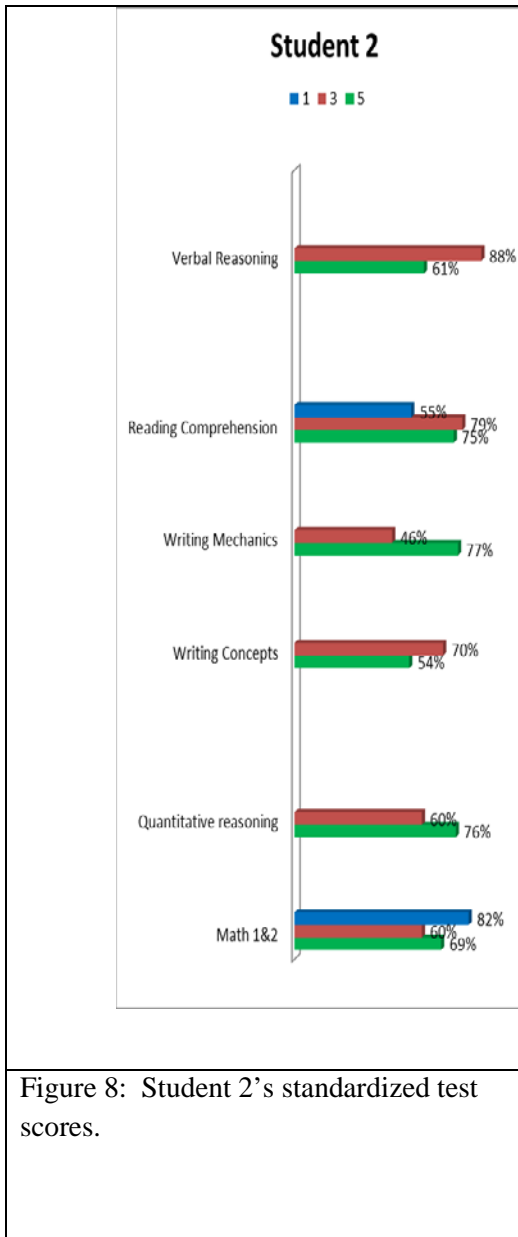
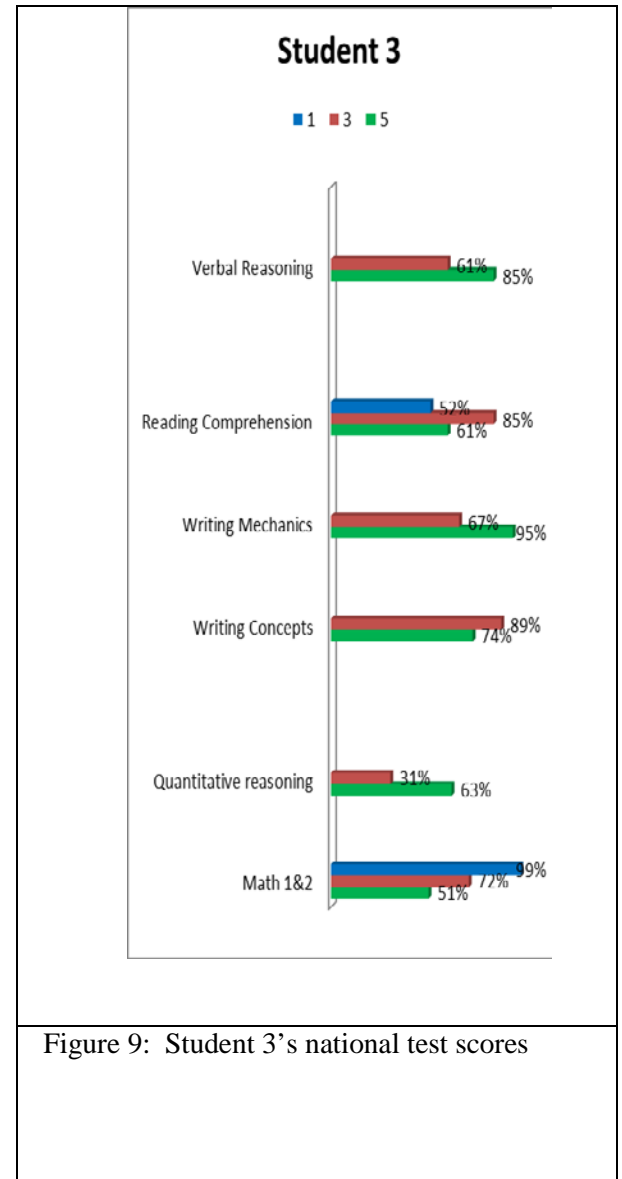


Figure 7: Student 1's standardized test scores.

Most of student 1's third grade scores were lost in the storm (Fig. 7). The student was very well prepared to enter first grade, and appears to have been about two standard deviations from the norm in verbal skills, and somewhat less in quantitative skills.



A normative student, S2 responded well to explicit connections towards abstract thought, but did not appear to have been able to create these connections on their own (Fig. 8).



S3 continued to decline relative to her peers in Math. But her quantitative and qualitative reasoning skills have been strengthened, as well as their writing mechanics scores (Fig. 9).



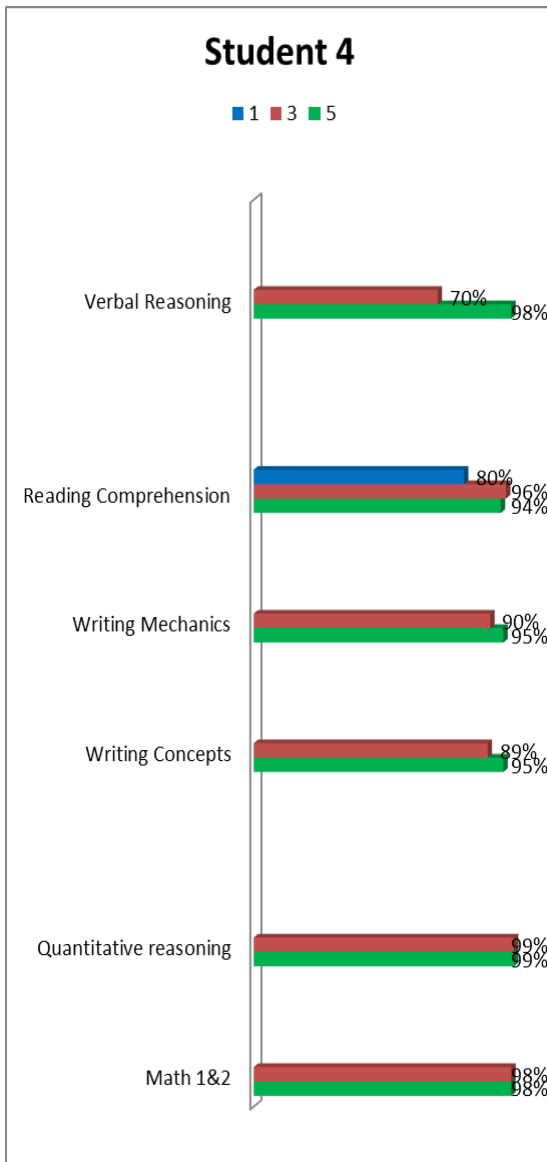


Figure 10: Student 4's standardized test scores.

By the end of the third grade S4 had only one weakness – verbal reasoning. Practicing reasoning skills seems to have rectified that weakness, and by the end of the fifth grade the student is performing well in all areas (Fig. 10).

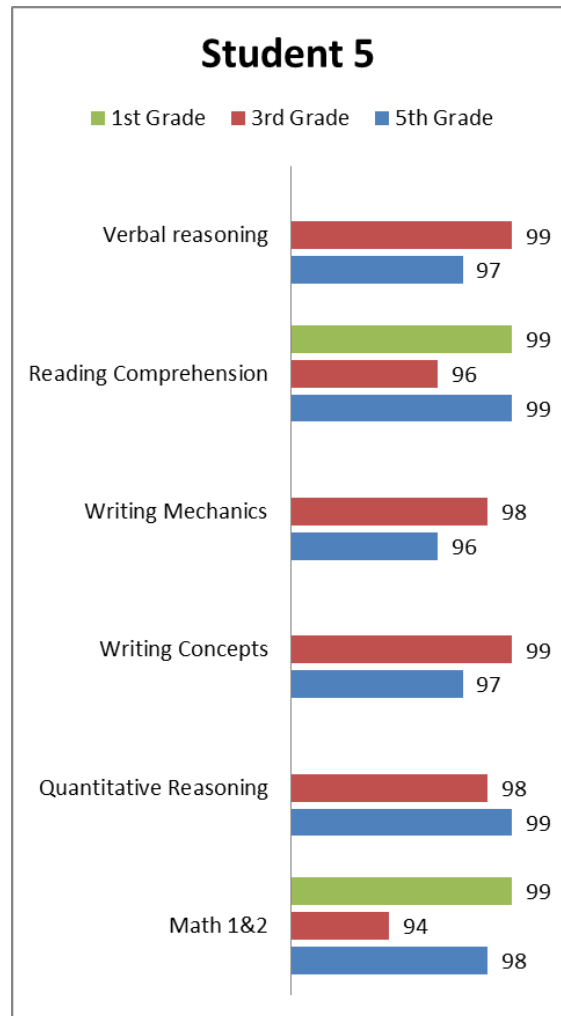


Figure 11: Student 5's standardized test scores.

Student 5 appears to be near three standard deviations above the norm and may be learning quite differently than his classmates. None-the-less he has also improved his math score (Fig. 11).

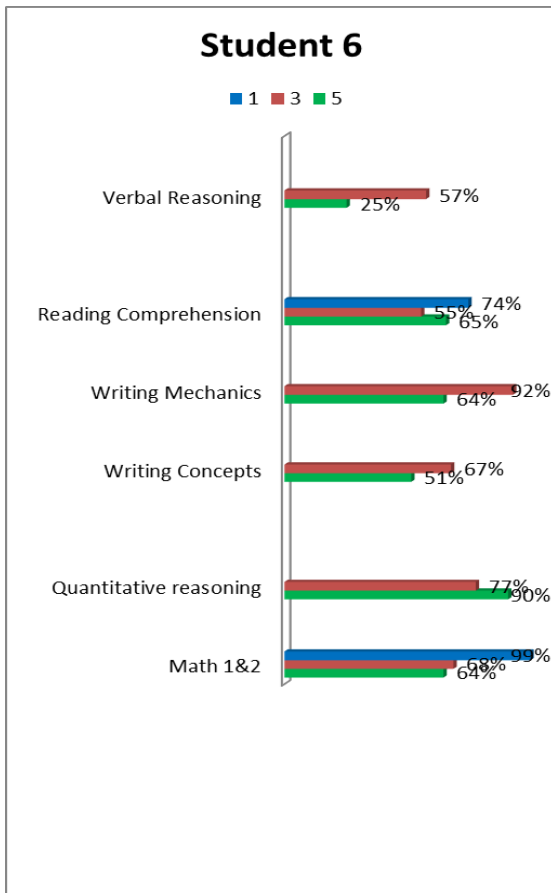


Figure 12: Student 6's standardized test scores.

Student 6 has continued an overall decline in performance since the first grade (Fig. 12).

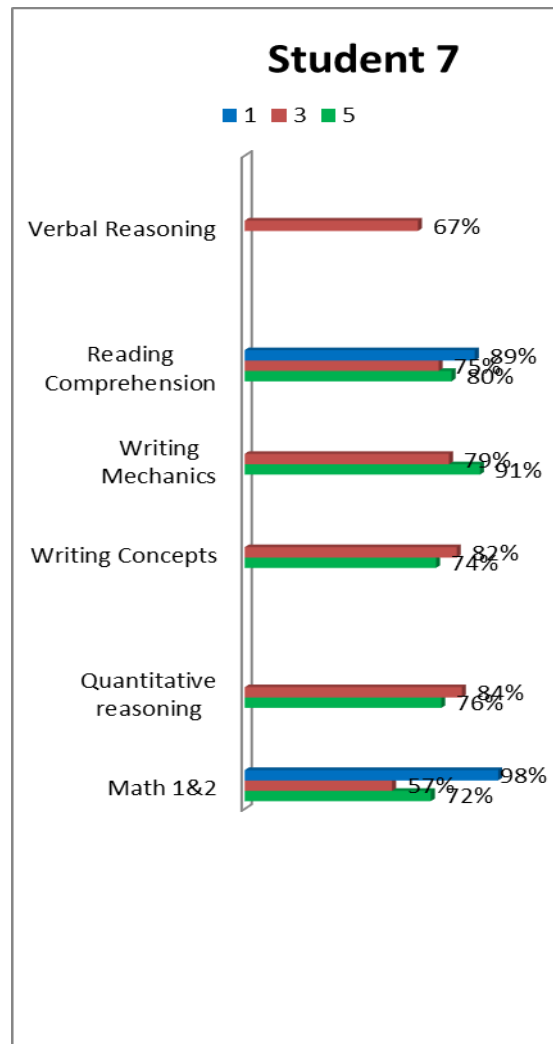


Figure 13: Student 7's standardized test scores.

Student 7 appears to be near one standard deviation from the norm, but stronger in verbal skills. They did not improve in either writing concepts or quantitative reasoning, but did improve in mathematics and reading and writing. In other words they appear to have learned exactly what was taught, but were not yet able to form abstractions to find other places where the acquired skill set applies (Fig. 13).

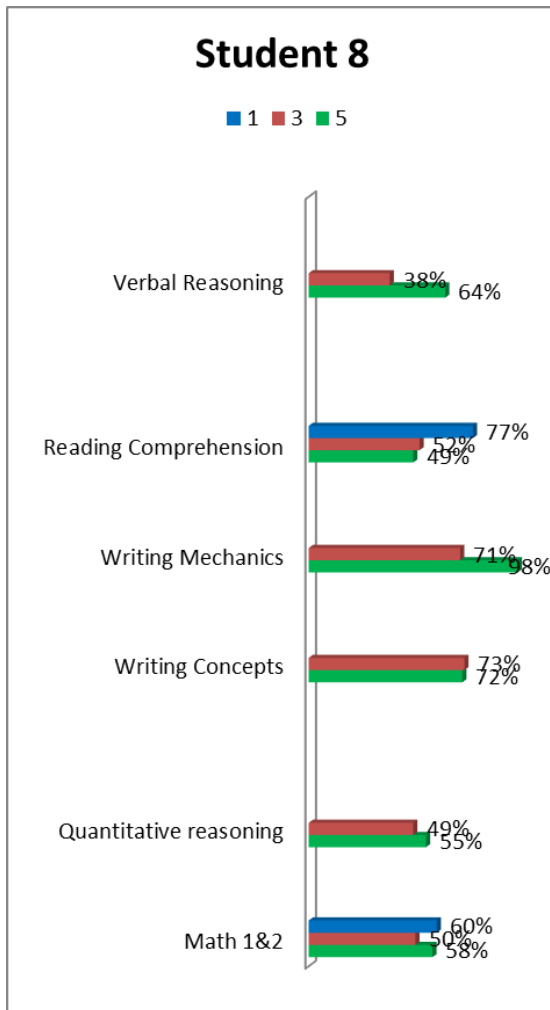


Figure 14: Student 8's standardized test scores.

Student 8 appears to be a normative student. Working on the book strengthened writing mechanics, while both qualitative and quantitative reasoning skills improved. Math also improved (Fig. 14).

### Conclusions

We conclude that, by the 5th grade, the majority of these students were ready for a more formal treatment of mathematics, while a minority self-differentiated themselves by not fully participating. Further, explicit in-depth examples helped a significant number of students to improve their reasoning skills.

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